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Chinook Salmon Escapement in the Chena, Salcha, and Goodpaster Rivers and Coho Salmon Escapement in the Delta Clearwater River, 2011–2012

by

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and

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March 2014

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	\$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA REPORT NO. 14-16

CHINOOK SALMON ESCAPEMENT IN THE CHENA, SALCHA, AND GOODPASTER RIVERS AND COHO SALMON ESCAPEMENT IN THE DELTA CLEARWATER RIVER, 2011–2012

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ABSTRACT

Salmon enumeration projects in the Tanana River drainage were conducted in 2011 and 2012 by the Alaska Department of Fish and Game (ADF&G) on the Chena and Delta Clearwater rivers and on the Salcha and Goodpaster rivers by Bering Sea Fishermen's Association (BSFA) and Tanana Chiefs Corporation (TCC), respectively. Chinook salmon *Oncorhynchus tshawytscha* and chum salmon *O. keta* escapements for the Chena, Salcha, and Goodpaster rivers were estimated using tower-counting methodology; and coho salmon *O. kisutch* escapement in the Delta Clearwater River was estimated by a visual boat survey conducted at peak escapement. This report details work conducted by ADF&G on the Chena and Delta Clearwater rivers and serves as an archive for count data collected on the Salcha and Goodpaster rivers.

Chena River: In 2011, a counting tower was in operation from 23 June through 27 July; however, an estimate of escapement was not derived because multiple high-water events and subsequent turbid water conditions prevented assessment of the majority of the run. A total of 195 Chinook salmon were counted during late July, but this was insufficient information to evaluate whether the escapement goal of 2,800–5,700 salmon was met. A total of 487 Chinook salmon were collected during carcass surveys to estimate age, sex, and length composition of the escapement. Dominant age classes were ages 1.3 and 2.2 (56%) for males and age 1.4 (68%) for females. The sample proportion of females was 0.32 (SE = 0.02), and the proportion adjusted for gender-bias was 0.23 (SE = 0.05). Mean length of females was 819 mm (SE = 5), and mean length of males was 671 mm (SE = 6).

In 2012, the counting tower was in operation from 5 July through 5 August. Estimated escapements were 2,220 (SE = 127) Chinook salmon and 6,882 (SE = 283) chum salmon. Chinook salmon escapement was below the established escapement goal. A total of 241 Chinook salmon carcasses were collected to estimate the age, sex, and length composition of the escapement. Dominant age classes were age 1.3 (64%) for males and age 1.4 (69%) for females. The sample proportion of females was 0.55 (SE = 0.03), and the proportion adjusted for gender-bias was 0.39 (SE = 0.08). Mean length of females was 798 mm (SE = 17) and mean length of males was 719 mm (SE=10).

Delta Clearwater River: Peak escapement counts of coho salmon escapement in the Delta Clearwater River were 16,544 in 2011 and 5,230 in 2012. Both counts were within the range of the escapement goal of 5,200–17,000.

Salcha River: Estimated escapements of Chinook salmon to the Salcha River were 7,200 in 2011 and 7,165 in 2012 (SEs not reported). Age, sex, and length composition estimates are provided. Escapements in both years exceeded the escapement goal of 3,300–6,500 Chinook salmon. Minimum estimates of chum salmon escapements were 66,564 in 2011 and 46,251 in 2012 (SEs not reported) .

Goodpaster River: Estimated escapements of Chinook salmon to the Goodpaster River were 1,325 in 2011 and 778 in 2012 (SEs not reported).

Keywords: Chinook salmon, *Oncorhynchus tshawytscha,* chum salmon, *O. keta*, coho salmon, *O. kisutch*, Chena River, Delta Clearwater River, Salcha River, Goodpaster River, counting tower, escapement.

INTRODUCTION

The primary purpose of this report is to present findings from salmon escapement enumeration projects in the Tanana River drainage conducted by ADF&G, Sport Fish Division (ADF&G-SF), during 2011 and 2012. These projects included a counting tower enumeration project on the Chena River to estimate total escapement of Chinook salmon *Oncorhynchus tshawytscha* and partial escapement of chum salmon *O. keta*, and a roving boat survey count to estimate escapement of coho salmon *O. kisutch* in the Delta Clearwater River. The main body of this report details methodologies and results from these two assessment projects.

Secondarily, this report presents data summaries and estimates of escapement of Chinook salmon from counting tower projects conducted during 2011 and 2012 by the Bering Sea Fisherman's Association (BSFA) on the Salcha River and by Tanana Chiefs Conference (TCC) on the Goodpaster River. Information from these two projects is in this report at the request of BSFA and TCC as a means of archiving the count data and escapement estimates in a publication that is easily accessible by stakeholders and other researchers. Information pertinent to the Salcha and Goodpaster rivers enumeration studies are in Appendix A and Appendix B, respectively.

The Chena and Salcha rivers support the largest spawning populations of Chinook salmon on the Alaskan side of the Yukon River drainage, while the Delta Clearwater River (DCR) supports the largest spawning population of coho salmon *O. kisutch* in the entire Yukon River drainage. The Goodpaster, Chatanika, and Nenana rivers also support important spawning populations of Chinook and coho salmon.

The *Policy for the Management of Sustainable Salmon Fisheries* (SSFP; 5 AAC 39.222, 2001) directs the Alaska Department of Fish and Game (department) to provide the Alaska Board of Fisheries (board) with reports on the status of salmon stocks and identify any salmon stocks that present a concern related to yield, management, or conservation. In 2000, the board classified Yukon Chinook salmon as a yield concern. A stock of yield concern is defined as "a concern arising from a chronic inability, despite the use of specific management measures, to maintain expected yields, or harvestable surpluses, above a stock's escapement needs" (5 AAC 39.222(f)(42)).

Also in 2000, in response to the board's designation, a management plan (*Yukon River King Salmon Management Plan* 5AAC 05.360) and biological escapement goals (BEGs) of 2,800–5,700 Chinook salmon in the Chena River and 3,300–6,500 in the Salcha River were established by the department in attempts to provide for maximum sustained yield. In contrast, a sustainable escapement goal (SEG) of 5,200–17,000 coho salmon in the Delta Clearwater River (DCR) was established because the spawner-recruit information required to establish a BEG was not available. There are currently no escapement goals for any salmon stocks in the Chatanika, Goodpaster, or Nenana rivers.

In 2001, the Alaska Board of Fisheries (BOF) directed ADF&G to manage Chinook and coho salmon harvests so that escapements fall within the BEGs and SEG. Currently the Yukon River Chinook salmon fisheries (commercial, subsistence, personal-use, and sport) are managed under the *Yukon River King Salmon Management Plan* (5 AAC 05.360) and the *Chena and Salcha River King Salmon Sport Harvest Management Plan* (5 AAC 74.060). The combined plans manage the commercial, subsistence, personal-use, and sport fisheries through fishery gear, bag limit, and timing restrictions to achieve the established escapement goals first and then the amount necessary for subsistence (ANS) throughout the entire Alaskan portion of the Yukon River drainage.

Commercial gillnet (drift and set) fisheries for Chinook salmon have not taken place since 2007. Commercial harvests show a substantial decrease in average yield from 100,000 fish during the 10-year historical period of high production (1989–1998) to the recent 5-year (2008–2012) average of approximately 3,000 (Schmidt and Newland 2012). Currently, the commercial harvest of coho salmon takes place during commercial openings on fall chum salmon. The plan allows for commercial fishing of coho salmon when fall chum runs are in excess of 550,000 fish. The 5-year average (2004–2008) was 44,750 fish.

Subsistence and personal-use gillnet (drift and set) and fish wheel fisheries take place throughout the Yukon and Tanana River drainages. During 2007–2011, Chinook salmon harvests were within the established ANS (45,500–66,704) only 1 out of 5 years. Prior to 2008, annual subsistence harvest had remained relatively stable near 50,000 Chinook salmon (Schmidt and Newland 2012). The 5-year (2004-2008) average harvest of subsistence and personal-use coho salmon was 21,277 fish (Borba et al. 2009).

The Chena River Chinook salmon sport fishery takes place in the Chena River downstream from all spawning areas. The 5-year (2007–2011) average sport catch of Chinook salmon in the Chena River was 795 fish, and the corresponding average harvest was 151 fish (Jennings et al. 2009, 2010a, 2010b, 2011, *In prep*). The recent 5-year (2007–2011) average sport catch of Chinook salmon in the Salcha River was 947 fish, and the corresponding average harvest was 268 fish (Jennings et al. 2009, 2010a, 2010b, 2011, *In prep*). Sport fishing on the Goodpaster River was opened in 2007 but limited to catch-and-release only. In 2007–2008 and 2010, the reported sport catch was zero. In 2009, the sport catch was 104 fish (Jennings et al. 2009, 2010a, 2010b, 2011, *In prep*). The 5-year (2007–2011) average sport catch of coho salmon in the Delta Clearwater River was 2,994 fish, and the corresponding average harvest was 195 fish (Jennings et al. 2009, 2010a, 2010b, 2011, *In prep*).

To determine whether the established escapement goals are met, counting tower techniques were used to enumerate the Chinook salmon escapements in the Chena, Salcha, and Goodpaster rivers, whereas visual boat surveys were used to estimate coho escapement in the Delta Clearwater River (DCR). The monitoring programs provide information on run magnitude and timing, which allows managers to modify fishing regulations to achieve the established escapement goals.

OBJECTIVES

The objectives in 2011 and 2012 were to:

1. estimate the total escapement of Chinook salmon in the Chena River using tower-counting techniques;
2. estimate age, sex, and length compositions of the escapement of Chinook salmon in the Chena River; and
3. count coho salmon in navigable portions of the Delta Clearwater River to index spawning escapement.

In addition to the objectives there was an additional task:

- estimate escapement of chum salmon in the Chena River throughout the duration of the Chinook salmon run.

METHODS

CHENA RIVER CHINOOK SALMON

In 2011, daily escapements of Chinook and chum salmon were estimated by visually counting fish from the deck of the Moose Creek Dam as they passed over white fabric panels located on the river bottom on the upstream side of the dam on the Chena River (Figure 1). In 2012, the counting tower site was moved just upriver from the Moose Creek Dam because the water hydraulics at the dam site had caused a large eddy to form that disturbed the flash panels. Counts were conducted from a scaffolding tower on the north bank of the river. Lights were suspended over the panels to provide illumination during periods of low ambient light. Counting begins on or about 25 June and continues into August until there are 3 continuous days with no net upstream passage of Chinook salmon. Virtually all Chinook salmon spawning occurs upstream of this site and no harvest of salmon is allowed upstream of the dam, so final estimates represent the total escapement.

Five technicians were assigned to enumerate the salmon escapement in the Chena River. Each day was divided into three 8 h shifts. Shift I began at 0000 hours (midnight) and ended at 0759 hours; Shift II began at 0800 hours and ended at 1559 hours; and Shift III began at 1600 hours and ended at 2359 hours. The start time for all counts began between the top of the hour and 10 min past.

The project was designed to count all salmon passing upstream and downstream for 20 minutes every hour over the course of the run. The numbers of Chinook and chum salmon were recorded on field forms at the end of each 20 min count. In addition, the technician would evaluate and record the water clarity conditions (Table 1) and river height from a staff gauge mounted on the dam. Only counts with a rank of 3 or higher were used in the estimate of escapement. A count with a rank of 4 or 5 was considered as no count. Each day, the data sheets from the previous day were returned to the project leader at the end of Shift I.

In 2008, a Dual-frequency Identification Sonar (DIDSON; Model 300 Sound Metrics Corp., Lake Forest Park, WA) was deployed at the tower site and a mixture model based on length was used to allocate the total count of salmon passing the sonar into numbers of Chinook and chum salmon. Results were compared to actual tower counts and suggested this methodology is an appropriate means to estimate passage when conditions prohibit tower counts (Huang 2012).

In 2011, two DIDSON sonar units were deployed downstream of the Moose Creek Dam on both sides of the river to estimate the number of migrating salmon during periods of high-water (> 2 consecutive days) when tower counts could not be completed. In 2012, the sonars were located just upstream of the counting panels. The objective was to position each sonar so it could record images from each half of the river, 24 hours a day, 7 days a week. Previous tower counts have shown that the majority of the Chinook salmon migrate up the north side of the river at the tower site, but that is likely due to a deeper channel located on that side of the river. In 2011, on the north side, the DIDSON was mounted to a 6.7 m aluminum rail that allowed the sonar to be moved up and down the river bank depending on water depth with a pulley mechanism. On the south side, the DIDSON was mounted to a portable aluminum tripod that is moved manually to adjust for water depth. Small weir structures were deployed at each site to ensure migrating salmon pass through the sonar beam. In 2012, both sonars were mounted on the portable aluminum tripods.

In addition to the tower counts, carcasses of spawned-out Chinook salmon were collected during the first 2 weeks of August from the dam upriver to the second bridge (Figure 1) to estimate age and sex composition of the escapement. Lengths were also measured. Ages were determined from scale patterns as described by Mosher (1969). Three scales were removed from the left side of the fish approximately 2 rows above the lateral line along a diagonal line downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Welander 1940). If no scales were present in the preferred area due to decomposition, scales were removed from the same area on the right side of the fish or, if necessary, from any location with remaining scales other than along the lateral line.

Two riverboats with a minimum of 3 people in each boat (1 operator and 2 people collecting carcasses) were used to collect Chinook salmon carcasses. Chinook salmon carcasses were speared from the boats and collected along banks and gravel bars and in pools. After collection, the carcasses were placed in a large tub onboard the boat. Once the tub was full, the boat was landed on a gravel bar and the carcasses were laid out in rows of 10 with their left sides facing up. After sampling, all carcasses were cut in a distinctive manner through the left side of the fish to avoid resampling and returned to the river.

DELTA CLEARWATER COHO SALMON

Previous aerial surveys of the DCR drainage have shown that an average of 20% of the coho salmon escapement is found in areas inaccessible to a boat survey; therefore, counts of adult coho salmon were conducted to obtain a minimum estimate of escapement. This estimate was used to evaluate whether or not the SEG was met.

Two people (a boat operator and a counter) conducted the survey from a drifting riverboat equipped with a 5 ft elevated platform. The survey is typically done during peak spawning times over the course of 1 to 2 days. The survey was conducted along the lower 18 miles of the Delta Clearwater River to within 1.0 mile of the Clearwater Lake outlet (Figure 2). The total number of coho salmon observed (both dead and alive) were recorded every mile at mile markers posted on the river bank. Section counts were summed to estimate minimum escapement.

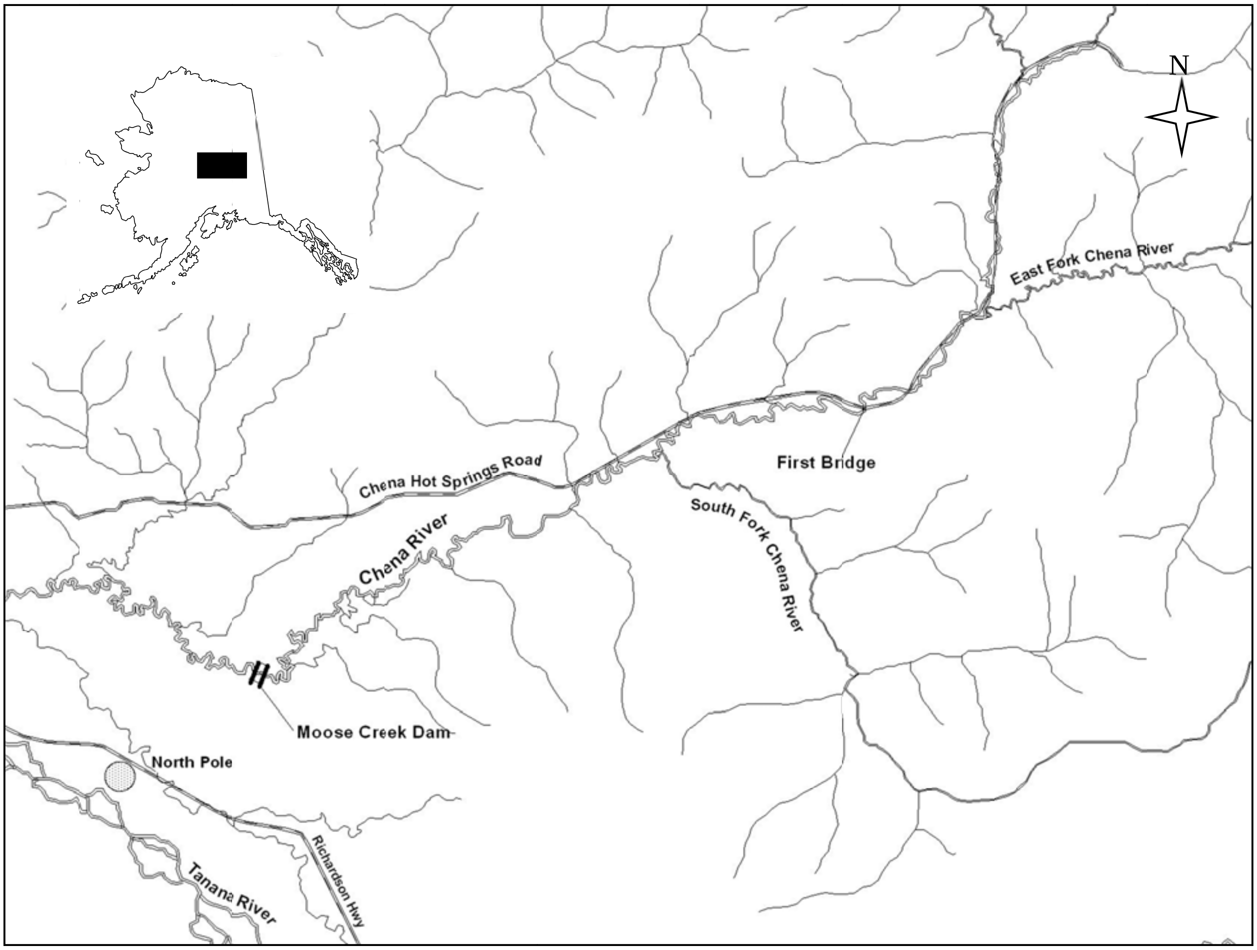

Figure 1.–Map of the Chena River showing the locations of the Moose Creek Dam where the counting tower is located and the first bridge on Chena Hot Springs Road, which was the upstream extent of carcass sampling.

Table 1.–Water clarity classification.

Rank	Description	Salmon Viewing	Water Condition
1	Excellent	All passing salmon are observable	Virtually no turbidity or glare, "drinking water" clarity; all routes of passage observable
2	Good	All passing salmon are observable	Minimal to moderate levels of turbidity or glare; all routes of passage observable
3	Fair	Possible, but not likely, that some passing salmon may be missed	Moderate to high levels of turbidity or glare; a few likely routes of passage are partially obscured
4	Poor	Likely that some passing salmon may be missed	Moderate to high levels of turbidity or glare; some or many likely routes of passage are obscured
5	Unobservable	Passing fish are not observable	High level of turbidity or glare; ALL routes of passage obscured

DATA ANALYSIS (CHENA RIVER CHINOOK SALMON)

Estimates of Chinook salmon escapement were stratified by day. Daily estimates of escapement were considered a two-stage direct expansion where the first stage was 8 h shifts within a day and the second stage was counting periods within a shift. The second stage was considered systematic sampling because the counting periods were not chosen randomly.

The formulas necessary to calculate escapement from counting tower data were taken directly or modified from those provided in Cochran (1977). The expanded shift escapement on day *d* and shift *i* was calculated by:

$$Y_{di} = \frac{M_{di}}{m_{di}} \sum_{j=1}^{m_{di}} y_{dij} \,. \qquad (1)$$

The average shift escapement for day *d* would be:

$$\overline{Y}_d = \frac{\sum_{i=1}^{h_d} Y_{di}}{h_d} \,. \qquad (2)$$

The following criteria were established to determine the methods used to estimate the daily escapement and its variance:

1. when 2 or more shifts are considered complete, escapement and variance will be estimated using equations 3–8;
2. when counts were only conducted during 1 shift but all 8 counting periods were sampled, escapement will be estimated using equation 3 and variance will be estimated by back-calculating using equation 11; and
3. when no shifts are considered complete, interpolation techniques described in equations 12 and 13 will be used to estimate escapement and back-calculating using equation 11 will be used to estimate variance.

A minimum of 4 counting periods per shift were required for a complete shift. Counts were conducted during all scheduled counting periods unless water clarity conditions prohibit counts.

The expanded daily escapement was:

$$\hat{N}_d = \overline{Y}_d H_d \,. \qquad (3)$$

The period sampled was systematic, because a period was sampled every hour in a shift. The sample variance associated with periods would be approximate using the successive difference approach:

$$s_{2di}^2 = \frac{1}{2(m_{di}-1)} \sum_{j=2}^{m_{di}} \left(y_{dij} - y_{di(j-1)}\right)^2 \,. \qquad (4)$$

Shift sampling is random. The between shift sample variance was calculated as:

$$s_{1d}^2 = \frac{1}{h_d - 1}\sum_{i=1}^{h_d}\left(Y_{di} - \overline{Y}_d\right)^2 . \qquad (5)$$

The variance for the expanded daily escapement was estimated by:

$$\hat{V}\left(\hat{N}_d\right) = \left[\left(1 - f_{1d}\right)H_d^2 \frac{s_{1d}^2}{h_d}\right] + \qquad (6)$$

$$\left[\frac{1}{f_{1d}}\sum_{i=1}^{h_d}\left(\left(1 - f_{2di}\right)M_{di}^2 \frac{s_{2di}^2}{m_{di}}\right)\right]$$

where:

$$f_{1d} = \frac{h_d}{H_d}\text{; and,} \qquad (7)$$

$$f_{2di} = \frac{m_{di}}{M_{di}} \qquad (8)$$

and

- d = day;
- i = 8 h shift;
- j = 20 min counting period;
- y_{dij} = the observed 20 min period count;
- Y_{di} = expanded shift escapement;
- m_{di} = number of 20 min counting periods sampled within a shift;
- M_{di} = total number of possible 20 min counting periods within a day (24 would indicate a full day);
- h_d = number of 8 h shifts sampled within a day;
- H_d = total number of possible 8 h shifts within a day; and
- D = total number of possible days.

Total escapement and variance was estimated by:

$$\hat{N} = \sum_{d=1}^{D}\hat{N}_d \text{; and} \qquad (9)$$

$$\hat{V}\left(\hat{N}\right) = \sum_{d=1}^{D}\hat{V}(\hat{N}_d) . \qquad (10)$$

Equation 5, the sample variance across shifts, required data from more than 1 shift per day. In the event that water conditions and/or personnel constraints did not permit at least 2 shifts during a day, a coefficient of variation (CV) was calculated using all days when more than 1 shift was worked. The average CV was used to approximate the daily variation for those days when fewer than 2 shifts were worked. The coefficient of variation was used because it is independent of the magnitude of the estimate and is relatively constant throughout the run (Evenson 1995). The daily CV was calculated as:

$$CV_d = SE_d \big/ \hat{N}_d \; . \qquad (11)$$

When k consecutive days were not sampled due to adverse viewing conditions, the moving average estimate for the missing day i was calculated as:

$$\hat{N}_i = \frac{\sum_{j=i-k}^{i+k} I(day\, j \;\, was\, sampled)\hat{N}_j}{\sum_{j=i-k}^{i+k} I(day\; j\, was\, sampled)} \qquad (12)$$

where:

$$I(\cdot) = \begin{cases} 1 & when\, the\, condition\, is\, true \\ 0 & otherwise \end{cases} \qquad (13)$$

is an indicator function. The moving average procedure was only applied to data gaps that did not exceed 2 days (12 consecutive shifts).

Gender-selective sampling has been noted when comparing sex ratios of Chinook salmon collected during carcass surveys with those collected by electrofishing (Stuby 2001). Correcting the estimated sex composition estimates from a carcass survey to estimates we might observe in a completely random sample required analysis of data from previous years when mark-recapture experiments were conducted. The adjustment was based on paired mark-recapture and carcass survey data from the Chena River (1989–1992, 1995–1997, and 2000). Abundance estimates were generated for each gender, and the ratio of the abundance estimate of females to the total abundance was used to generate an unbiased estimate of the proportion of females in the population. A “correction factor” was calculated and applied to the estimated proportion of females in the carcass sample (in years when only carcass samples were collected) based on the average relationship between the proportion estimate from the mark-recapture estimates and the proportion estimates from the carcass samples for all 8 years (unpublished analysis from ADF&G Sport Fish Division, Fairbanks). A similar correction was developed for the Salcha River.

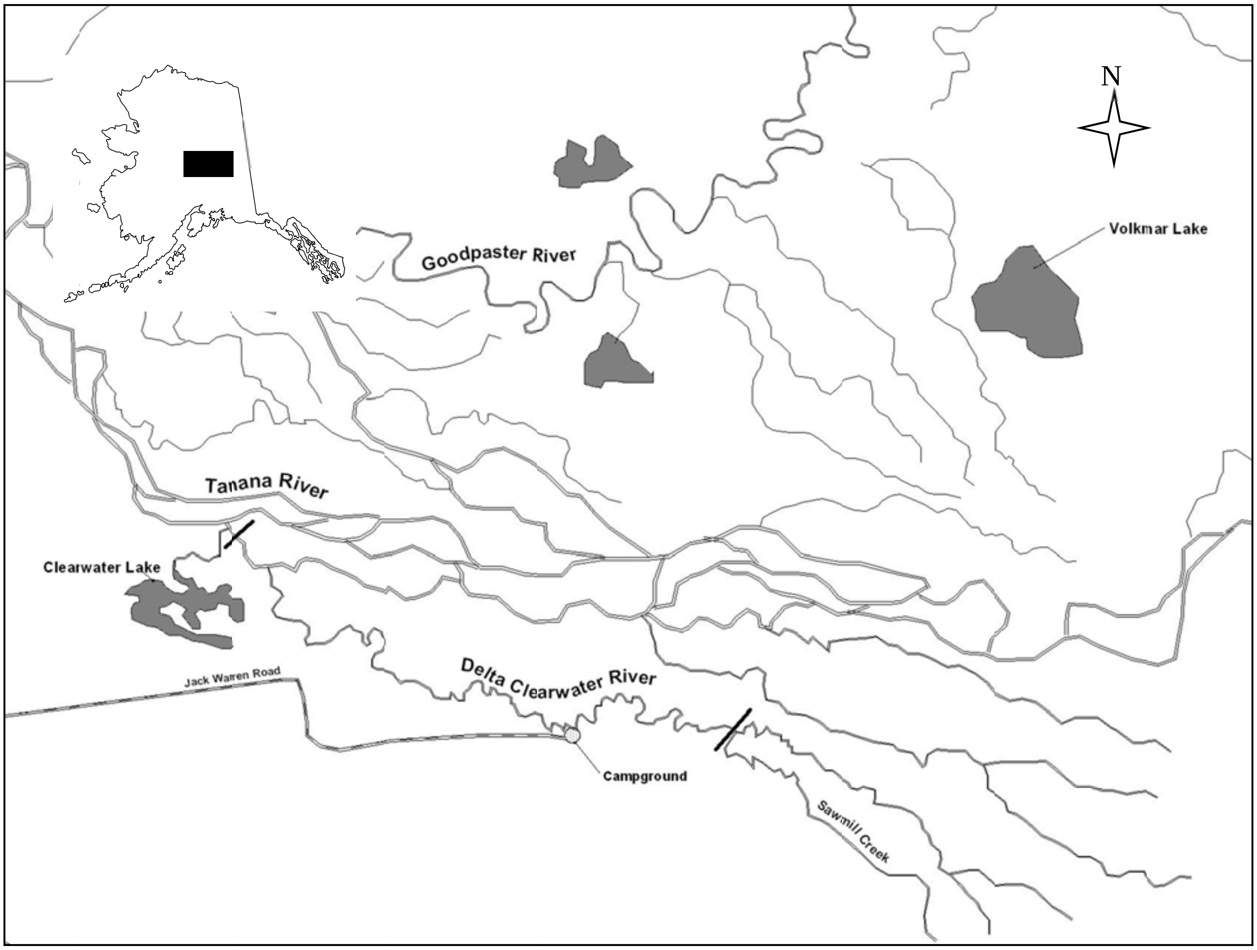

Figure 2.–Map of the Delta Clearwater River demarcating the survey area (bold lines).

The escapement estimate was apportioned by sex prior to apportioning by age categories within each sex. Estimates of the proportion of females and males in the escapement based on carcass surveys was adjusted to estimate what would have been observed from an electrofishing sample. The estimated proportions of males and females from carcass surveys were calculated using (Cochran 1977):

$$\hat{p}_{sc} = \frac{y_{sc}}{n_c}; \quad (14)$$

with variance:

$$\hat{V}[\hat{p}_{sc}] = \frac{\hat{p}_{sc}(1-\hat{p}_{sc})}{n_c - 1}; \quad (15)$$

where y_{sc} is the number of salmon of sex s observed during carcass surveys and n_c is the total number of salmon of either sex observed during carcass surveys for $s = m$ or f.

The adjustment necessary to compensate for the gender bias associated with carcass sampling is $\hat{R}_p$ = 0.708 with $\hat{V}(\hat{R}_p)$ = 0.018.

The bias-adjusted estimate and variance (Goodman 1960) of the proportion of females, $\tilde{p}_{fe}$, is:

$\tilde{p}_{fe} = \hat{p}_{fc}\hat{R}_p$ with variance:

$$\hat{V}(\tilde{p}_{fe}) = \hat{p}_{fc}^2\hat{V}(\hat{R}_p) + \hat{R}_p^2\hat{V}(\hat{p}_{fc}) - \hat{V}(\hat{R}_p)\hat{V}(\hat{p}_{fc}). \quad (16)$$

The bias-adjusted estimate and variance (Goodman 1960) of the proportion of males, $\tilde{p}_{me}$, is:

$\tilde{p}_{me} = 1 - \tilde{p}_{fe}$ and $\hat{V}(\tilde{p}_{me}) = \hat{V}(\tilde{p}_{fe})$.

Escapement of each sex is then estimated by:

$$\hat{N}_s = \tilde{p}_{se}\hat{N} \quad (17)$$

The variance for $\hat{N}_s$ in this case was (Goodman 1960):

$$\hat{V}(\hat{N}_s) = \hat{V}(\tilde{p}_{se})\hat{N}^2 + \hat{V}(\hat{N})\tilde{p}_{se}^2 - \hat{V}(\tilde{p}_{se})\hat{V}(\hat{N}). \quad (18)$$

The European aging system was used to characterize age composition. This system salmon includes the number of freshwater and ocean years of residence. For example, age 1.2 symbolizes 1 year of freshwater residence and 2 years in the ocean.

The proportion of fish at age k by sex s for samples collected solely for age, sex, and length were calculated as:

$$\hat{p}_{sk} = \frac{y_{sk}}{n_s} \quad (19)$$

where: $\hat{p}_{sk}$ = the estimated proportion of Chinook salmon that are age k; y_{sk} = the number of Chinook salmon sampled that are age k; and, n_s = the total number of Chinook salmon sampled.

The variance of this proportion was estimated as:

$$\hat{V}[\hat{p}_{sk}] = \frac{\hat{p}_{sk}(1-\hat{p}_{sk})}{n_s - 1} \quad (20)$$

Escapement at age k for each sex was then estimated by:

$$\hat{N}_{sk} = \hat{p}_{sk}\hat{N}_s \quad (21)$$

The variance for $\hat{N}_{sk}$ in this case was (Goodman 1960):

$$\hat{V}(\hat{N}_{sk}) = \hat{V}(\hat{p}_{sk})\hat{N}_s^2 + \hat{V}(\hat{N}_s)\hat{p}_{sk}^2 - \hat{V}(\hat{p}_{sk})\hat{V}(\hat{N}_s). \quad (22)$$

RESULTS

CHENA RIVER CHINOOK SALMON

2011 Field Season

The Chena River counting tower was in operation from 23 June through 27 July. A total of 195 Chinook salmon and 333 chum salmon were counted during this time frame; however, multiple high-water events coupled with extremely turbid water prevented the technicians from obtaining visual counts for the majority of days during the Chinook and chum salmon runs (Tables 2, 3, and 4; Figure 3). Therefore, no estimates of total escapement or descriptions of run timing for Chinook or chum salmon were derived in 2011.

Recorded DIDSON images of migrating salmon were collected intermittently from 23 June through 27 July. However, multiple high-water events prevented the sonar from capturing images from the majority of the river, and the recorded images could not be used to supplement the counting tower methods. The total number of salmon counted by sonar was 264.

Carcass surveys began on 3 August and ended on 11 August. A total of 487 Chinook salmon carcasses were sampled for age, sex, and length (ASL) data. Of the 487 carcasses sampled, 62 samples could not be aged.

The sex composition of the sampled carcasses was 0.32 (SE = 0.02) females and 0.68 (SE = 0.02) for males (Table 5). The sex composition adjusted for gender selective sampling was 0.23 (SE = 0.05) females and 0.77 (SE = 0.05) for males.

The age and length composition of the escapement was determined for each sex (Tables 7, 8, and 10). The dominant age classes were age 1.3 and 2.2 (56%) for males and age 1.4 (68%) for females.

2012 Field Season

The Chena River counting tower was in operation from 5 July through 5 August. Estimated escapement of Chinook salmon was 2,220 (SE = 127), which is lower than the established BEG (Tables 2 and 5; Figure 3). The estimated chum salmon escapement was 6,882 (SE = 283), which was considered a minimum estimate because tower counts were terminated before the chum run was completed (Table 6).

Run timing past the counting tower (Figure 4) was described by the day of the run to facilitate comparison among years (i.e., Day 1 equals the first Chinook salmon passing upriver during a scheduled count). The pattern observed over all available years (1997–1999, 2001, 2003–2004, 2006–2010, 2012) illustrates the average timing and span of the run.

Recorded DIDSON images of migrating salmon were collected from 5 July through 5 August. A high-water event from 21 July through 26 July prevented tower counts, but successful counts were completed using the recorded sonar images. The total number of salmon counted during the period of tower in operation was 1,360, of which 1,133 (SE = 35) were Chinook salmon and 227 (SE = 35) were chum salmon.

Carcass surveys began on 8 August and ended on 13 August. Of the 241 total carcasses sampled for ASL data, 43 samples could not be aged.

The sex composition of the sampled carcasses was 0.55 (SE = 0.03) females and 0.45 (SE = 0.03) for males (Table 5). The sex composition adjusted for gender-selective sampling was 0.39 (SE = 0.08) females and 0.61 (SE = 0.08) for males.

The age and length composition of the escapement was determined for each sex (Tables 7, 9, and 10). The dominant age classes were age 1.3 (64%) for males and age 1.4 (69%) for females.

DELTA CLEARWATER COHO SALMON

In 2011, the boat survey was conducted on 28 October and the minimum estimate of escapement was 16,544 coho salmon (Table 11).

In 2012, the boat survey was conducted on 19 October and the minimum estimate of escapement was 5,230 coho salmon (Table 11).

DISCUSSION

To evaluate whether the BEG was met, a precise estimate of escapement is required. In 2011, the majority of the Chena River Chinook salmon run was not enumerated because of multiple high-water events and sonar difficulties. These conditions prevented an estimate of total escapement. In 2012, the majority of the Chinook salmon run was enumerated under good viewing conditions, but the escapement goal was not met.

In 2011, the Chena River Chinook salmon fishery was restricted to catch-and-release only on 23 July. This action was taken because the Chena River counting tower was inoperable due to high and turbid water conditions, and lower river indicators suggested that the Chinook salmon run was weak (Brase and Baker 2012). Restrictions had been placed on subsistence, commercial, and sport users in the Yukon River, and closing the Chena River (and all other Tanana River tributaries) to retention of Chinook salmon seemed prudent based on recent years' production and the lack of data from the current year (Brase and Baker 2012).

Table 2.–Estimates of the Chena River Chinook salmon escapement, 1986–2012.

	Escapement		
Year	Estimate	SE	Method
1986	9,065	1,080	Mark-Recapture
1987	6,404	557	Mark-Recapture
1988	3,346	556	Mark-Recapture
1989	2,730	249	Mark-Recapture
1990	5,603	1,164	Mark-Recapture
1991	3,172	282	Mark-Recapture
1992	5,580	478	Mark-Recapture
1993	12,241	387	Counting Tower
1994	11,877	479	Counting Tower
1995	11,394	1,210	Mark-Recapture
1996	7,153	913	Mark-Recapture
1997	13,390	699	Counting Tower
1998	4,745	503	Counting Tower
1999	6,485	427	Counting Tower
2000	4,694	1,184	Mark-Recapture
2001	9,696	565	Counting Tower
2002	6,967	2,466	Mark-Recapture
2003	11,100	653	Counting Tower
2004	9,645	532	Counting Tower
2005	-	-	-
2006	2,936	163	Counting Tower
2007	3,806	226	Counting Tower
2008	3,208	198	Counting Tower
2009	5,253	231	Counting Tower
2010	2,382	152	Counting Tower
2011	-	-	-
2012	2,220	127	Counting Tower

Table 3.–Daily estimates of Chena River Chinook salmon escapement, 2011. Total escapement estimate was not derived due to multiple high-water events.

Date	Number of 20 Min. Counts	Number Counted	Daily Escapement	Daily SE
15-Jul	16	0	0	0.0
16-Jul	24	0	0	0.0
17-Jul	24	0	0	0.0
18-Jul	24	0	0	0.0
19-Jul	24	1	3	2.6
20-Jul	24	0	0	0.0
21-Jul	24	1	3	2.6
22-Jul	24	14	42	29.3
23-Jul	24	10	30	7.6
24-Jul	24	7	21	6.1
25-Jul	24	10	30	8.9
26-Jul	24	16	48	14.9
27-Jul	24	6	18	8.5
Total		65	195	36.7

Table 4.–Daily estimates of Chena River chum salmon escapement, 2011. A total escapement estimate was not derived due to multiple high-water events.

Date	Number of 20 Min Counts	Number Counted	Daily Escapement	Daily SE
15-Jul	16	0	0	0.0
16-Jul	24	0	0	0.0
17-Jul	24	0	0	0.0
18-Jul	24	0	0	0.0
19-Jul	24	0	0	0.0
20-Jul	24	1	3	2.6
21-Jul	24	0	0	0.0
22-Jul	24	2	6	5.2
23-Jul	24	4	12	3.7
24-Jul	24	2	6	3.7
25-Jul	24	50	150	36.2
26-Jul	24	39	117	34.2
27-Jul	24	13	39	13.0
Total		111	333	52.1

Table 5.–Daily estimates of Chena River Chinook salmon escapement, 2012.

Date	Number of 20 Min Counts[a]	Number Counted	Daily Escapement	Daily SE
5-Jul	8	0	0	0.0
6-Jul	8	0	0	0.0
7-Jul	16	0	0	0.0
8-Jul	19	1	3	1.9
9-Jul	24	0	0	0.0
10-Jul	24	0	0	0.0
11-Jul	24	3	9	6.4
12-Jul	24	9	27	8.7
13-Jul	24	11	33	11.9
14-Jul	24	13	39	16.4
15-Jul	16	24	108	55.9
16-Jul	23	40	125	31.5
17-Jul	24	34	102	16.2
18-Jul	24	50	150	38.3
19-Jul	24	33	99	16.6
20-Jul	24	30	90	14.1
21-26-Jul	Sonar	1,133	1,133	34.9
27-Jul	24	22	66	24.6
28-Jul	24	12	36	7.2
29-Jul	20	8	24	11.0
30-Jul	24	20	60	15.6
31-Jul	24	24	72	20.6
1-Aug	24	12	36	10.8
2-Aug	24	1	3	4.9
3-Aug	22	3	10	6.7
4-Aug	24	-2	-6	7.2
5-Aug	24	0	0	4.5
Total		1,481	2,220	127

[a] Sonar images are recorded 24 hours a day, 7 days a week so counts are considered a census.

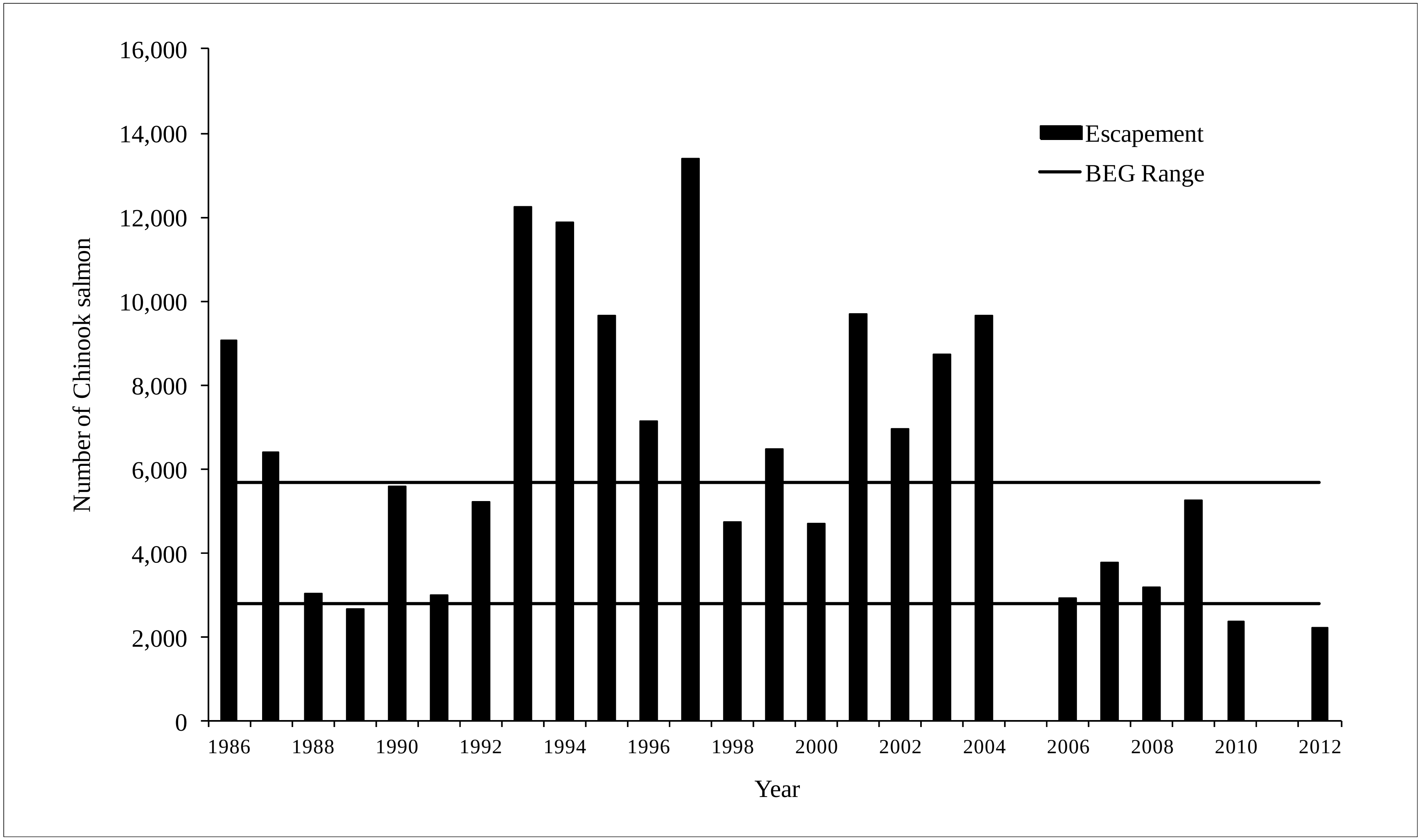

Figure 3.–Estimates of Chinook salmon escapements to the Chena and River and the respective BEG, 1986–2012.

Table 6.–Daily estimates of Chena River chum salmon escapement, 2012.

Date	Number of 20 Min Counts	Number Counted	Daily Escapement	Daily SE
5-Jul	8	0	0	0.0
6-Jul	8	0	0	0.0
7-Jul	16	0	0	0.0
8-Jul	19	1	3	2.6
9-Jul	24	0	0	0.0
10-Jul	24	0	0	0.0
11-Jul	24	0	0	0.0
12-Jul	24	8	24	16.6
13-Jul	24	7	21	3.7
14-Jul	24	3	9	4.5
15-Jul	16	2	9	8.3
16-Jul	23	14	44	19.8
17-Jul	24	4	12	8.7
18-Jul	24	20	60	12.6
19-Jul	24	10	30	7.9
20-Jul	24	42	126	28.1
21–26-Jul	Sonar	227	227	34.9
27-Jul	24	116	348	53.4
28-Jul	24	127	381	45.4
29-Jul	20	75	258	43.8
30-Jul	24	185	555	77.3
31-Jul	24	170	510	44.7
1-Aug	24	208	624	67.6
2-Aug	24	344	1,101	146.9
3-Aug	22	226	714	77.3
4-Aug	24	261	783	67.6
5-Aug	24	348	1,044	90.5
Total		2,398	6,882	282

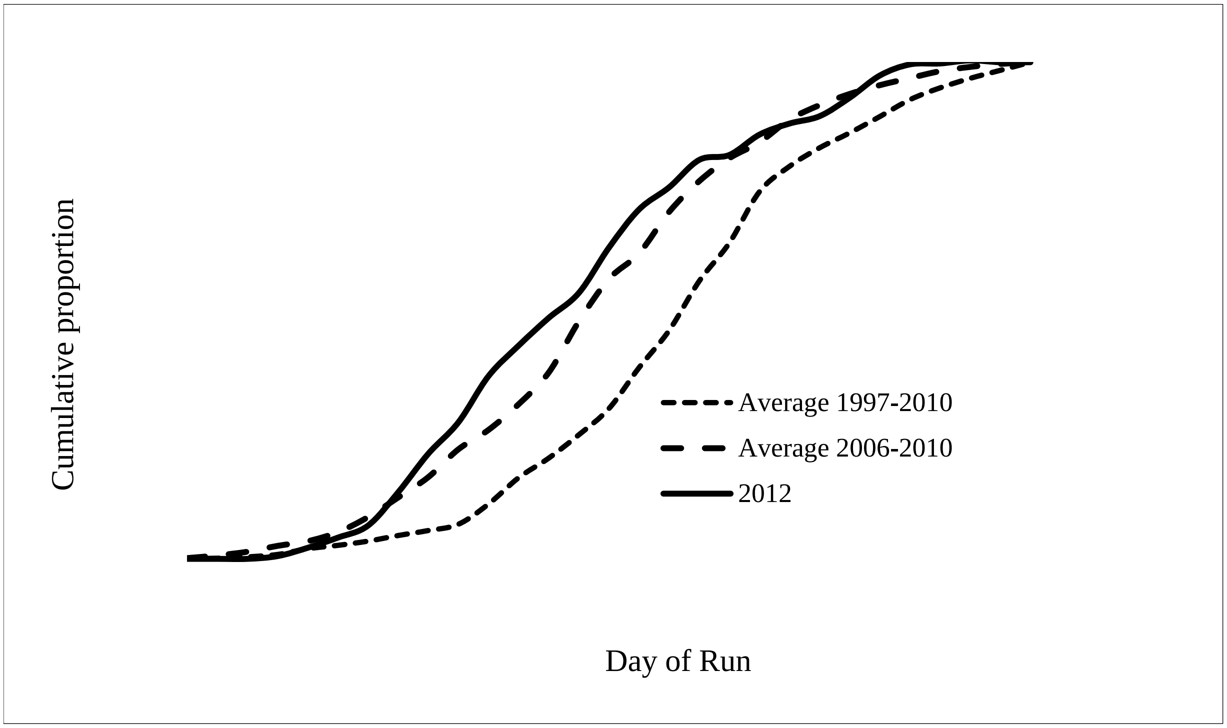

Figure 4.–Average run timing pattern for Chena River Chinook salmon past the counting tower over all years (1997–1999, 2001, 2003–2004, and 2006–2010), the last 5 years studied (2006–2010), and 2012.

Table 7.–Estimated proportions of male and female Chinook salmon sampled from carcass surveys on the Chena River, 1986–2012.

Year	Sexed Sample Size Males	Sexed Sample Size Females	Sexed Sample Proportion[a] Males	Sexed Sample Proportion[a] Females	Sexed and Aged Sample Size Males	Sexed and Aged Sample Size Females	Sexed and Aged Sample Proportion[a] Males	Sexed and Aged Sample Proportion[a] Females	Adjusted Sample Proportion[b] Males	Adjusted Sample Proportion[b] Females	Total Escapement	Method[c]
1986	987	365	0.73	0.27	538	183	0.75	0.25	0.75	0.25	9,065	MR
1987	438	592	0.43	0.57	235	325	0.42	0.58	0.52	0.48	6,404	MR
1988	347	543	0.39	0.61	183	285	0.39	0.61	0.66	0.34	3,346	MR
1989	119	218	0.35	0.65	101	187	0.35	0.65	0.55	0.45	2,730	MR
1990	291	258	0.53	0.47	291	258	0.53	0.47	0.64	0.36	5,603	MR
1991	231	108	0.68	0.32	231	108	0.68	0.32	0.68	0.32	3,172	MR
1992	289	176	0.62	0.38	289	176	0.62	0.38	0.78	0.22	5,580	MR
1993	205	38	0.84	0.16	156	31	0.83	0.17	0.88	0.12	12,241	CT
1994	326	275	0.54	0.46	281	231	0.55	0.45	0.68	0.32	11,877	CT
1995	305	593	0.34	0.66	267	520	0.34	0.66	0.48	0.52	11,394	MR
1996	286	229	0.56	0.44	286	229	0.56	0.44	0.73	0.27	7,153	MR
1997	424	278	0.60	0.40	424	278	0.60	0.40	0.74	0.26	10,810	MR
1998	160	107	0.60	0.40	134	94	0.59	0.41	0.72	0.28	4,745	CT
1999	75	133	0.36	0.64	61	116	0.34	0.66	0.55	0.45	6,485	CT
2000	113	56	0.67	0.33	99	50	0.66	0.34	0.78	0.22	4,694	MR
2001	342	253	0.57	0.43	292	229	0.56	0.44	0.70	0.30	9,696	CT
2002	277	216	0.56	0.44	207	167	0.55	0.45	0.73	0.27	6,967	MR
2003	253	206	0.55	0.45	204	166	0.55	0.45	0.68	0.32	11,100[d]	CT
2004	98	160	0.38	0.62	88	151	0.37	0.63	0.56	0.44	9,645	CT
2005	352	268	0.57	0.43	319	234	0.58	0.42	0.69	0.31	-	CT
2006	221	183	0.55	0.45	196	166	0.54	0.46	0.68	0.32	2,936	CT
2007	51	32	0.61	0.39	36	26	0.58	0.42	0.73	0.27	3,806	CT
2008	26	18	0.59	0.41	20	16	0.56	0.44	0.71	0.29	3,208	CT
2009	209	272	0.43	0.57	198	244	0.45	0.55	0.60	0.40	5,253	CT
2010	132	54	0.71	0.29	56	25	0.69	0.31	0.79	0.21	2,382	CT
2011	331	156	0.68	0.32	292	135	0.68	0.32	0.77	0.23	-	-
2012	107	132	0.44	0.56	88	110	0.44	0.56	0.61	0.39	2,220	CT/S
Average	289	237	0.55	0.45	206	176	0.55	0.45	0.68	0.32	6,575	

[a] Estimated proportions were all derived from carcass samples.

[b] In years when counting tower assessments (CT) were conducted and only carcass surveys were conducted, proportions of males and females were adjusted as described in equations 16–18. In years when mark-recapture experiments (MR) were conducted, proportions of males and females were estimated as the ratio of the abundance estimate of each gender to the abundance estimate of all fish.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment, sonar images, or a mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. Minimum documented abundance with large gaps in counts due to flooding was 8,739 (SE = 653) fish.

Table 8.–Estimated proportions and mean length by age and sex of Chinook salmon sampled during the Chena River carcass survey, 2011.

	Sample	Sample	Length (mm)			
Age[a]	Size	Proportion	Mean	SE	Min	Max
Males						
1.1	1	<0.01	335	-	-	-
1.2	96	0.33	559	5	420	660
1.3	163	0.56	701	3	570	775
2.2	1	<0.01	600	-	-	-
1.4	30	0.10	845	15	660	985
2.4	1	<0.01	705	-	-	-
Total Aged	292	0.68	671	6	335	985
Total Males[b]	331	0.68	671	6	335	985
Adjusted Total[c]		0.77	-	-	-	-
Female						
1.3	37	0.22	735	7	620	830
1.4	92	0.47	850	5	730	940
1.5	4	0.29	849	16	810	885
2.4	2	0.02	853	33	820	885
Total Aged	135	0.32	819	6	620	940
Total Females[b]	156	0.32	819	5	620	940
Adjusted Total[c]		0.23				

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents 1 annulus formed during river residence and 4 annuli formed during ocean residence for a total age of 6 years).

[b] Totals include those Chinook salmon which could not be aged.

[c] Estimated proportion of females was corrected by a factor of 0.708.

Table 9.–Estimated proportions and mean length by age and sex of Chinook salmon sampled during the Chena River carcass survey, 2012.

	Sample	Sample	Length (mm)			
Age[a]	Size	Proportion	Mean	SE	Min	Max
Males						
1.1	1	0.01	340	-	-	-
1.2	10	0.11	550	19	425	670
1.3	56	0.64	707	7	570	835
2.2	0	0.00	-	-	-	-
1.4	21	0.24	815	14	690	950
2.4	0	0.00	-	-	-	-
Total Aged	88	0.44	702	14	340	950
Total Males[b]	107	0.45	719	10	340	950
Adjusted Total[c]		0.61	-	-	-	-
Female						
1.3	34	0.31	741	7	645	800
1.4	76	0.69	820	5	745	955
1.5	0	0.00	-	-	-	-
2.4	0	0.00	-	-	-	-
Total Aged	110	0.56	798	17	645	955
Total Females[b]	132	0.55	796	5	645	955
Adjusted Total[c]		0.39				

[a]Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents 1 annulus formed during river residence and 4 annuli formed during ocean residence for a total age of 6 years).

[b]Totals include those Chinook salmon which could not be aged.

[c]Estimated proportion of females was adjusted by a factor of 0.708.

Table 10.–Age composition and escapement estimates by gender and by all fish combined (unadjusted and adjusted) of Chena River Chinook salmon, 1986–2012.

Males	Total Age (years)/European Age (freshwater years/ocean years)										Male	Male
	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1986	0.002	0.126	0.636	0.000	0.197	0.019	0.020	0.000	0.000	0.000	6,618	6,764
1987	0.000	0.064	0.281	0.000	0.613	0.009	0.034	0.000	0.000	0.000	2,723	3,320
1988	0.016	0.268	0.355	0.000	0.279	0.000	0.082	0.000	0.000	0.000	1,305	2,212
1989	0.010	0.109	0.495	0.020	0.347	0.010	0.010	0.000	0.000	0.000	964	1,492
1990	0.000	0.423	0.309	0.003	0.254	0.000	0.010	0.000	0.000	0.000	2,970	3,569
1991	0.000	0.126	0.489	0.000	0.312	0.000	0.074	0.000	0.000	0.000	2,161	2,172
1992	0.031	0.682	0.208	0.000	0.080	0.000	0.000	0.000	0.000	0.000	3,468	4,373
1993	0.006	0.355	0.445	0.000	0.187	0.000	0.006	0.000	0.000	0.000	10,327	10,804
1994	0.000	0.053	0.644	0.000	0.292	0.004	0.007	0.000	0.000	0.000	6,442	8,029
1995	0.000	0.131	0.360	0.000	0.491	0.000	0.015	0.004	0.000	0.000	3,870	5,509
1996	0.038	0.108	0.629	0.000	0.136	0.000	0.087	0.000	0.000	0.000	3,972	5,239
1997	0.005	0.611	0.184	0.000	0.196	0.000	0.002	0.002	0.000	0.000	6,529	8,038
1998	0.000	0.075	0.858	0.000	0.045	0.000	0.022	0.000	0.000	0.000	2,843	3,399
1999	0.000	0.115	0.377	0.000	0.508	0.000	0.000	0.000	0.000	0.000	2,338	3,527
2000	0.000	0.303	0.444	0.000	0.222	0.000	0.030	0.000	0.000	0.000	3,139	3,675
2001	0.010	0.154	0.462	0.000	0.353	0.000	0.021	0.000	0.000	0.000	5,573	6,777
2002	0.000	0.001	0.004	0.000	0.001	0.000	0.001	0.000	0.000	0.000	3,915	5,063
2003	0.000	0.088	0.623	0.000	0.240	0.000	0.049	0.000	0.000	0.000	6,118	7,573
2004	0.000	0.295	0.318	0.000	0.364	0.000	0.023	0.000	0.000	0.000	3,664	5,410
2005	0.000	0.110	0.571	0.000	0.292	0.000	0.016	0.013	0.000	0.000	-	-
2006	0.000	0.235	0.592	0.005	0.148	0.005	0.015	0.000	0.000	0.000	1,606	1,994
2007	0.194	0.222	0.306	0.000	0.278	0.000	0.000	0.000	0.000	0.000	2,339	2,767
2008	0.000	0.150	0.750	0.000	0.100	0.000	0.000	0.000	0.000	0.000	1,896	2,279
2009	0.000	0.313	0.293	0.000	0.394	0.000	0.000	0.000	0.000	0.000	2,282	3,150
2010	0.000	0.196	0.518	0.018	0.250	0.000	0.018	0.000	0.000	0.000	1,690	1,892
2011	0.003	0.331	0.555	0.003	0.103	0.000	0.000	0.003	0.000	0.000	-	-
2012	0.011	0.114	0.636	0.000	0.239	0.000	0.000	0.000	0.000	0.000	994	1,352
Average	0.007	0.238	0.461	0.002	0.269	0.002	0.021	0.001	0.000	0.000	3,700	4,544

-continued-

Table 10.–Page 2 of 4.

Females	Total Age (years)/European Age (freshwater years/ocean years)										Female	Female
	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1986	0.000	0.000	0.131	0.000	0.552	0.000	0.306	0.005	0.000	0.005	2,447	2,301
1987	0.000	0.003	0.022	0.000	0.855	0.000	0.114	0.006	0.000	0.000	3,681	3,084
1988	0.000	0.000	0.060	0.000	0.582	0.000	0.351	0.000	0.000	0.007	2,041	1,134
1989	0.000	0.005	0.187	0.000	0.652	0.000	0.155	0.000	0.000	0.000	1,766	1,238
1990	0.000	0.008	0.194	0.000	0.733	0.000	0.066	0.000	0.000	0.000	2,633	2,034
1991	0.000	0.000	0.120	0.000	0.620	0.000	0.231	0.009	0.009	0.009	1,011	1,000
1992	0.000	0.000	0.284	0.000	0.710	0.000	0.006	0.000	0.000	0.000	2,112	1,207
1993	0.000	0.000	0.258	0.000	0.710	0.000	0.032	0.000	0.000	0.000	1,914	1,437
1994	0.000	0.000	0.182	0.000	0.771	0.004	0.043	0.000	0.000	0.000	5,435	3,848
1995	0.000	0.000	0.131	0.000	0.821	0.000	0.044	0.004	0.000	0.000	7,524	5,885
1996	0.000	0.004	0.210	0.000	0.358	0.000	0.428	0.000	0.000	0.000	3,181	1,914
1997	0.000	0.007	0.058	0.000	0.914	0.000	0.022	0.000	0.000	0.000	4,281	2,772
1998	0.000	0.000	0.532	0.000	0.383	0.000	0.085	0.000	0.000	0.000	1,902	1,346
1999	0.000	0.009	0.181	0.000	0.810	0.000	0.000	0.000	0.000	0.000	4,147	2,958
2000	0.000	0.000	0.180	0.000	0.620	0.000	0.200	0.000	0.000	0.000	1,555	1,019
2001	0.000	0.022	0.175	0.000	0.716	0.000	0.087	0.000	0.000	0.000	4,123	2,919
2002	0.000	0.000	0.003	0.000	0.005	0.000	0.006	0.000	0.000	0.000	3,052	1,904
2003	0.000	0.006	0.271	0.000	0.633	0.000	0.090	0.000	0.000	0.000	4,982	3,527
2004	0.000	0.000	0.086	0.000	0.881	0.000	0.033	0.000	0.000	0.000	5,981	4,235
2005	0.000	0.004	0.402	0.000	0.530	0.004	0.043	0.017	0.000	0.000	1,761	1,247
2006	0.000	0.000	0.289	0.000	0.705	0.000	0.006	0.000	0.000	0.000	1,330	942
2007	0.038	0.154	0.423	0.000	0.385	0.000	0.000	0.000	0.000	0.000	1,467	1,039
2008	0.000	0.000	0.438	0.000	0.438	0.000	0.125	0.000	0.000	0.000	1,312	929
2009	0.000	0.008	0.070	0.000	0.910	0.000	0.012	0.000	0.000	0.000	2,971	2,103
2010	0.000	0.000	0.480	0.000	0.480	0.000	0.040	0.000	0.000	0.000	692	490
2011	0.000	0.000	0.274	0.000	0.681	0.000	0.030	0.015	0.000	0.000	-	-
2012	0.000	0.000	0.309	0.000	0.691	0.000	0.000	0.000	0.000	0.000	1,226	868
Average	0.000	0.009	0.219	0.000	0.669	0.000	0.099	0.002	0.000	0.001	2,979	2,135

-continued-

Table 10.–Page 3 of 4.

Unadjusted[a]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1986	0.001	0.094	0.508	0.000	0.287	0.014	0.093	0.001	0.000	0.001	9,065	MR
1987	0.000	0.029	0.130	0.000	0.754	0.004	0.080	0.004	0.000	0.000	6,404	MR
1988	0.006	0.105	0.175	0.000	0.464	0.000	0.246	0.000	0.000	0.004	3,346	MR
1989	0.003	0.042	0.295	0.007	0.545	0.003	0.104	0.000	0.000	0.000	2,730	MR
1990	0.000	0.228	0.255	0.002	0.479	0.000	0.036	0.000	0.000	0.000	5,603	MR
1991	0.000	0.086	0.372	0.000	0.410	0.000	0.124	0.003	0.003	0.003	3,172	MR
1992	0.019	0.424	0.234	0.002	0.316	0.002	0.002	0.000	0.000	0.000	5,580	MR
1993	0.005	0.294	0.412	0.000	0.278	0.000	0.011	0.000	0.000	0.000	12,241	CT
1994	0.000	0.029	0.436	0.000	0.508	0.004	0.023	0.000	0.000	0.000	11,877	CT
1995	0.000	0.044	0.208	0.000	0.709	0.000	0.034	0.004	0.000	0.000	11,394	MR
1996	0.021	0.062	0.443	0.000	0.235	0.000	0.239	0.000	0.000	0.000	7,153	MR
1997	0.003	0.372	0.134	0.000	0.480	0.000	0.010	0.001	0.000	0.000	10,810	MR
1998	0.000	0.044	0.724	0.000	0.184	0.000	0.048	0.000	0.000	0.000	4,745	CT
1999	0.000	0.045	0.249	0.000	0.706	0.000	0.000	0.000	0.000	0.000	6,485	CT
2000	0.003	0.302	0.390	0.000	0.283	0.000	0.022	0.000	0.000	0.000	4,694	MR
2001	0.006	0.096	0.336	0.000	0.512	0.000	0.050	0.000	0.000	0.000	9,696	CT
2002	0.000	0.238	0.278	0.000	0.444	0.000	0.040	0.000	0.000	0.000	6,967	MR
2003	0.000	0.051	0.465	0.000	0.416	0.000	0.068	0.000	0.000	0.000	11,100	CT
2004	0.000	0.109	0.172	0.000	0.690	0.000	0.029	0.000	0.000	0.000	9,645	CT
2005	0.000	0.065	0.499	0.000	0.392	0.002	0.027	0.014	0.000	0.000	4,075	CT
2006	0.000	0.127	0.453	0.003	0.403	0.003	0.011	0.000	0.000	0.000	2,936	CT
2007	0.129	0.194	0.355	0.000	0.323	0.000	0.000	0.000	0.000	0.000	3,806	CT
2008	0.000	0.083	0.611	0.000	0.250	0.000	0.056	0.000	0.000	0.000	3,208	CT
2009	0.000	0.145	0.170	0.000	0.679	0.000	0.007	0.000	0.000	0.000	5,253	CT
2010	0.000	0.136	0.506	0.012	0.321	0.000	0.025	0.000	0.000	0.000	2,382	CT
2011	0.002	0.226	0.466	0.002	0.287	0.000	0.009	0.007	0.000	0.000	-	-
2012	0.005	0.051	0.455	0.000	0.490	0.000	0.000	0.000	0.000	0.000	2,220	CT/S
Average	0.004	0.137	0.351	0.001	0.446	0.001	0.058	0.001	0.000	0.000	6,679	

-continued-

Table 10.–Page 4 of 4.

Adjusted[b]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1986	0.001	0.094	0.508	0.000	0.287	0.014	0.093	0.001	0.000	0.001	9,065	MR
1987	0.000	0.035	0.156	0.000	0.730	0.004	0.072	0.003	0.000	0.000	6,404	MR
1988	0.011	0.177	0.255	0.000	0.382	0.000	0.173	0.000	0.000	0.002	3,346	MR
1989	0.005	0.062	0.355	0.011	0.485	0.005	0.076	0.000	0.000	0.000	2,730	MR
1990	0.000	0.272	0.267	0.002	0.428	0.000	0.030	0.000	0.000	0.000	5,603	MR
1991	0.000	0.086	0.373	0.000	0.409	0.000	0.123	0.003	0.003	0.003	3,172	MR
1992	0.027	0.574	0.194	0.000	0.204	0.000	0.001	0.000	0.000	0.000	5,580	MR
1993	0.006	0.311	0.421	0.000	0.253	0.000	0.009	0.000	0.000	0.000	12,241	CT
1994	0.000	0.036	0.494	0.000	0.447	0.004	0.019	0.000	0.000	0.000	11,877	CT
1995	0.000	0.063	0.241	0.000	0.661	0.000	0.030	0.004	0.000	0.000	11,394	MR
1996	0.028	0.081	0.517	0.000	0.196	0.000	0.179	0.000	0.000	0.000	7,153	MR
1997	0.004	0.456	0.152	0.000	0.380	0.000	0.007	0.002	0.000	0.000	10,810	MR
1998	0.000	0.053	0.766	0.000	0.141	0.000	0.040	0.000	0.000	0.000	4,745	CT
1999	0.000	0.066	0.288	0.000	0.646	0.000	0.000	0.000	0.000	0.000	6,485	CT
2000	0.003	0.302	0.390	0.000	0.283	0.000	0.022	0.000	0.000	0.000	4,694	MR
2001	0.007	0.114	0.376	0.000	0.462	0.000	0.041	0.000	0.000	0.000	9,696	CT
2002	0.002	0.307	0.302	0.000	0.369	0.000	0.020	0.000	0.000	0.000	6,967	MR
2003	0.000	0.062	0.511	0.000	0.365	0.000	0.062	0.000	0.000	0.000	11,100[d]	CT
2004	0.000	0.166	0.216	0.000	0.591	0.000	0.027	0.000	0.000	0.000	9,645	CT
2005	0.000	0.077	0.519	0.000	0.364	0.001	0.024	0.014	0.000	0.000	-	-
2006	0.000	0.159	0.495	0.003	0.327	0.003	0.012	0.000	0.000	0.000	2,936	CT
2007	0.152	0.204	0.338	0.000	0.307	0.000	0.000	0.000	0.000	0.000	3,806	CT
2008	0.000	0.107	0.659	0.000	0.198	0.000	0.036	0.000	0.000	0.000	3,208	CT
2009	0.000	0.191	0.204	0.000	0.600	0.000	0.005	0.000	0.000	0.000	5,253	CT
2010	0.000	0.156	0.510	0.014	0.297	0.000	0.022	0.000	0.000	0.000	2,382	CT
2011	0.003	0.256	0.491	0.003	0.235	0.000	0.007	0.006	0.000	0.000	-	-
2012	0.007	0.069	0.508	0.000	0.415	0.000	0.000	0.000	0.000	0.000	2,220	CT/S
Average	0.010	0.170	0.368	0.001	0.405	0.001	0.044	0.001	0.000	0.000	6,575	

[a] Unadjusted escapement and composition estimates were derived from the observed sample proportions of males and females from carcass surveys.

[b] Adjusted escapement and composition estimates were derived either from mark-recapture estimates (MR) or, in years when counting tower (CT) assessments were conducted, from carcass surveys that were adjusted using the methods described in equations 16–18 and do not necessarily reflect actual sample proportions.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment, sonar (S), or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. CV is a minimum estimate and does not include uncertainty associated with expansion for missed days. Minimum documented abundance with large gaps in counts due to flooding was 8,739 (SE = 653) fish.

Table 11.–Minimum estimates of escapement for Delta Clearwater River coho salmon, 1980–2012.

Year	Survey Date	Minimum Escapement
1980	28 Oct	3,946
1981	21 Oct	8,563
1982	3 Nov	8,365
1983	25 Oct	8,019
1984	6 Nov	11,061
1985	13 Nov	6,842
1986	21 Oct	10,857
1987	27 Oct	22,300
1988	28 Oct	21,600
1989	25 Oct	12,600
1990	26 Oct	8,325
1991	23 Oct	23,900
1992	26 Oct	3,963
1993	21 Oct	10,875
1994	24 Oct	62,675
1995	23 Oct	20,100
1996	29 Oct	14,075
1997	24 Oct	11,525
1998	20 Oct	11,100
1999	28 Oct	10,975
2000	24 Oct	9,225
2001	19 Oct	46,875
2002	31 Oct	38,625
2003	21 Oct	105,850
2004	27 Oct	37,950
2005	25 Oct	34,293
2006	24 Oct	16,748
2007	31 Oct-1 Nov	14,650
2008	30 Oct	7,500
2009	26 Oct	16,850
2010	30 Oct	5,867
2011	28 Oct	16,544
2012	19 Oct	5,230
Average		19,633

In 2012, the Chena River Chinook salmon sport fishery was closed because the run was not projected to meet minimum escapement and, as in 2011, restrictions in lower river fisheries took place. This proved to be the appropriate management action, because the run did not meet minimum escapement (Table 4).

The sex composition estimates of the 2011 escapement were similar to 2010 (Z = 2.07, P = 1.96). The adjusted proportion of females (0.23) was slightly higher than it was in 2010 (0.21), which was the lowest proportion of females to date. In 2012, the sex composition (0.39) was significantly different than in 2011 (0.23) (Z = -14.63, P <0.01). There are typically more males in the Chena River escapement than females, but the increase from 21–23% females to 39% should benefit future returns.

The age composition estimates of the 2011 and 2012 escapements were similar to the estimates over all years studied (1986–2010), with the exception of salmon age 5 (1.3 and 2.2) and age 6 (1.4 and 2.3). However, the proportion of salmon age 5 and 6 tend to complement one another, and this relationship is lost when averaging over time. In other words, when there is a large proportion of age 5 salmon in a particular year, there is typically a smaller proportion of age 6, and vice versa.

The DCR boat count was conducted in 2011 and 2012 over 1 day under good conditions, and it produced minimum estimates of escapement within the established SEG. Previous studies have expanded the boat count to account for the escapement to inaccessible tributaries in the DCR drainage. This expansion was done to conduct a spawner-recruit analysis and was in no way used to evaluate whether the SEG was met. For this reason, the minimum escapement estimate that is used to evaluate the SEG will be the only one reported.

In 2011, the DCR coho salmon sport fishery was not subject to any further restrictions because the projected escapement was well above the established SEG. In 2012, the fishery was restricted to catch-and-release fishing because the run was not projected to meet the SEG. The fishery was not further restricted because the coho salmon run was thought to be holding further downriver due to unusually high water in the middle Tanana River (Brase and Baker 2012). The SEG was achieved in both years (Table 11).

CONCLUSION

Continued assessment of the Chena, Salcha, and Delta Clearwater rivers is required to determine whether the established escapement goals for the largest Chinook and coho salmon spawning tributaries in the Alaska portion of the Yukon River drainage are met. Consistently poor returns to the Chena River are concerning, and numerous projects are being proposed to look at early life history of juvenile salmon. Currently, the Alaska Sustainable Salmon Fund (AKSSF) is funding the Chena River counting tower through 2015. The coho salmon counts are annually funded through ADF&G General Funds, and the Salcha and Goodpaster river projects are funded through 2014 from Research and Management (R&M) Funds for the Yukon River distributed by USFWS.

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REFERENCES CITED

Brase, A. L., and B. Baker 2012. Fishery management report for recreational fisheries in the Tanana River management area, 2011. Alaska Department of Fish and Game, Fishery Management Report No. 12-46, Anchorage.

Cochran, W. G. 1977. Sampling techniques. 3rd edition. John Wiley, New York.

Evenson, M. J. 1995. Salmon studies in Interior Alaska, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 95-5, Anchorage.

Goodman, L. A. 1960. On the exact variance of products. Journal of the American Statistical Association 55:708-713.

Huang, J. 2012. Sonar-based Chena River salmon assessment 2008. Alaska Department of Fish and Game, Fishery Data Series No. 12-39, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2009. Estimates of participation, catch and harvest in Alaska sport fisheries during 2006. Alaska Department of Fish and Game, Fishery Data Series 09-54, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2010a. Estimates of participation, catch and harvest in Alaska sport fisheries during 2007. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2010b. Estimates of participation, catch and harvest in Alaska sport fisheries during 2008. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2011. Estimates of participation, catch and harvest in Alaska sport fisheries during 2009. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Jennings, G. B., K. Sundet, and A. E. Bingham. *In prep*. Estimates of participation, catch and harvest in Alaska sport fisheries during 2010. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Mosher, K. H. 1969. Identification of Pacific salmon and steelhead trout by scale characteristics. United States Department of the Interior, U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, D.C., Circular 317.

Schmidt, S. N., and E. Newland 2012. Yukon River king salmon stock status, action plan, and summer chum salmon fishery, 2012, a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Special Publication No. 12-30, Anchorage.

Stuby, L. 2001. Salmon studies in interior Alaska, 2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-24, Anchorage.

Welander, A. D. 1940. A study of the development of the scale of the Chinook salmon (*Oncorhynchus tshawytscha*). Master's thesis, University of Washington, Seattle.

APPENDIX A:
SALCHA RIVER CHINOOK SALMON COUNTING TOWER DATA

Appendix A1.–Data summaries and estimates of escapement of Chinook salmon from counting tower projects by Bering Sea Fisherman's Association (BSFA) on the Salcha River, 2011–2012.

Appendix A: List of Figures

Figure **Page**

Appendix A: List of Tables

Table **Page**

INTRODUCTION

Bering Sea Fishermen's Association (BSFA) began tower counts on the Salcha River in 1999. Further details regarding this project can be obtained by contacting the BSFA.

METHODS

Project mobilization, escapement enumeration, and data analysis procedures for the Salcha River counting tower were virtually identical to those used for the Chena River.

RESULTS

In 2011, the Salcha River counting tower (Figure A1) was in operation from 15 July to 15 August; multiple high water events prevented complete counts of the salmon run so estimates were interpolated. The estimated Chinook salmon escapement during that time was 7,200 fish (SE = not reported, Tables A1 and A2). The estimated chum salmon escapement during that time was 66,564 fish (SE = not reported, Table A4).

In 2012, the Salcha River counting tower (Figure A1) was in operation from 17 July to 15 August; the estimated Chinook salmon escapement during that time was 7,165 fish (SE = 163, Tables A1 and A3). The estimated chum salmon escapement during that time was 46,251 fish (SE = 580, Table A5).

AGE-SEX-LENGTH COMPOSITIONS

In 2011, a total of 601 Chinook salmon carcasses were collected along the Salcha River from 31 July through 10 August. The estimated proportion of females in the escapement from the carcass survey was 0.42 (SE = 0.02) and the gender-bias corrected estimate was 0.36 (SE = 0.07). The largest age class for males (57%) was age 1.3, whereas the largest for females (91%) was age 1.4 (Tables A6 and A8).

In 2012, a total of 504 Chinook salmon carcasses were collected along the Salcha River from 6 August through 17 August. The estimated proportion of females in the escapement from the carcass survey was 0.59 (SE = 0.02) and the gender-bias corrected estimate was 0.51 (SE = 0.10). The largest age class for males (51%) was age 1.3, whereas the largest for females (77%) was age 1.4 (Tables A7 and A8).

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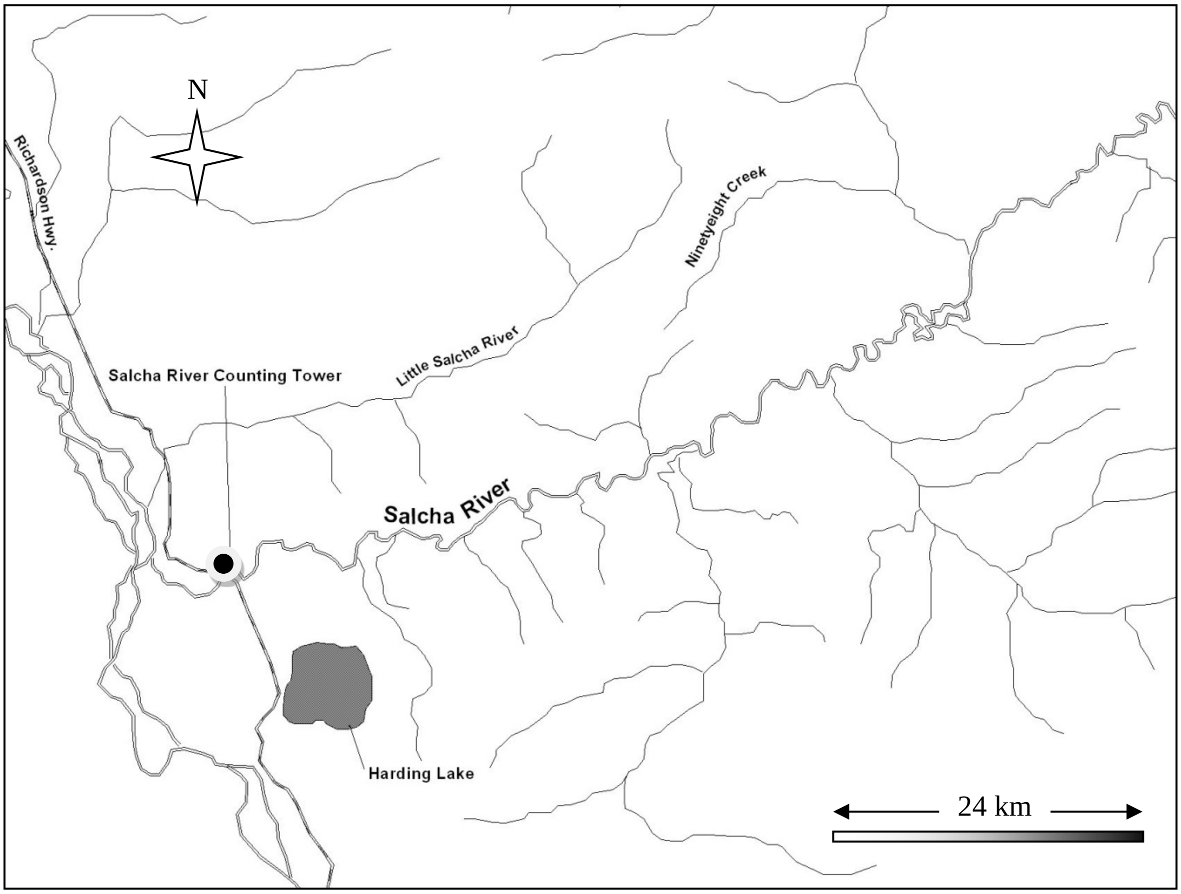

Figure A1.–Map of the Salcha River showing the location of the counting tower.

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Table A1.–Estimates of the Salcha River Chinook salmon escapement, 1987 – 2012.

	Escapement		
Year	Estimate	SE	Method[b]
1987	4,771	504	M-R
1988	4,322	556	M-R
1989	3,294	630	M-R
1990	10,728	1,404	M-R
1991	5,608	664	M-R
1992	7,862	975	M-R
1993	10,007	360	CT
1994	18,399	549	CT
1995	13,643	471	CT
1996	7,570	1,238	M-R
1997	18,514	1,043	CT
1998	5,027	331	CT
1999	9,198	290	CT
2000	4,595	802	CT
2001	13,328	2,163	CT
2002	9,000[a]	160	CT
2003	15,500[a]	747	CT
2004	15,761	612	CT
2005	5,988	163	CT
2006	10,679	315	CT
2007	6,425	225	CT
2008	5,415[a]	169	CT
2009	12,774	405	CT
2010	6,135	170	CT
2011	7,200[a]	-[c]	CT
2012	7,165	163	CT

[a] Estimate was obtained from an expansion of the interrupted tower-count.

[b] Escapement estimates were obtained from either a counting tower (CT) assessment or a mark-recapture (MR) project.

[c] Standard error not reported by BSFA.

Table A2.–Daily estimates of Salcha River Chinook salmon escapement, 2011. Bold numbers are interpolated using daily passage percentages from complete count days in 2009–2011.

Date	Day of Run	Number 20 Min Counts	Daily Escapement
15-Jul			
16-Jul			
17-Jul	1	8	234
18-Jul	2		
19-Jul	3		
20-Jul	4	8	297
21-Jul	5		**400**
22-Jul	6		**400**
23-Jul	7	8	477
24-Jul	8		**400**
25-Jul	9	5	475
26-Jul	10	24	360
27-Jul	11	5	158
28-Jul	12		**250**
29-Jul	13		**200**
30-Jul	14		**150**
31-Jul	15		**100**
1-Aug	16	16	45
2-Aug	17	20	83
3-Aug	18	20	25
4-Aug	19	24	78
5-Aug	20	24	90
6-Aug	21	24	54
7-Aug	22	24	48
8-Aug	23	20	22
9-Aug	24	24	27
10-Aug	25	24	27
11-Aug	26	10	14
12-Aug	27		**20**
13-Aug	28		**20**
14-Aug	29		**12**
Total			7,200

Table A3.–Daily estimates of Salcha River Chinook salmon escapement, 2012.

Date	Day of Run	Number 20 Min Counts	Daily Escapement
15-Jul			
16-Jul			
17-Jul	1	5	115
18-Jul	2	24	249
19-Jul	3	24	453
20-Jul	4	24	411
21-Jul	5	8	171
22-Jul	6	16	198
23-Jul	7	24	333
24-Jul	8	24	726
25-Jul	9	24	597
26-Jul	10	24	738
27-Jul	11	24	984
28-Jul	12	24	651
29-Jul	13	24	453
30-Jul	14	24	216
31-Jul	15	24	219
1-Aug	16	24	123
2-Aug	17	24	102
3-Aug	18	24	159
4-Aug	19	24	60
5-Aug	20	24	45
6-Aug	21	24	42
7-Aug	22	24	60
8-Aug	23	24	42
9-Aug	24	24	12
10-Aug	25	24	9
11-Aug	26	24	-3
12-Aug		24	0
13-Aug		24	0
14-Aug		24	0
Total			7,165

Table A4.–Daily estimates of Salcha River chum salmon escapement, 2011. Bold numbers are interpolated using daily passage percentages from complete count days in 2009–2011.

Date	Day of Run	Number 20 Min Counts	Daily Escapement
19-Jul	1		100
20-Jul	2	8	207
21-Jul	3		**300**
22-Jul	4		**500**
23-Jul	5		**700**
24-Jul	6		**900**
25-Jul	7	5	1,238
26-Jul	8	24	1,440
27-Jul	9	5	3,427
28-Jul	10		**3,000**
29-Jul	11		**3,000**
30-Jul	12		**3,000**
31-Jul	13		**3,000**
1-Aug	14	16	2,624
2-Aug	15	20	3,917
3-Aug	16	20	4,727
4-Aug	17	24	4,404
5-Aug	18	24	4,668
6-Aug	19	24	4,083
7-Aug	20	24	4,707
8-Aug	21	20	3,852
9-Aug	22	24	4,503
10-Aug	23	24	4,005
11-Aug	24	10	4,262
Total			66,564

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Table A5.–Daily estimates of Salcha River chum salmon escapement, 2012.

Date	Day of Run	Number of 20 Min Counts	Daily Escapement
17-Jul	1	5	101
18-Jul	2	24	102
19-Jul	3	24	165
20-Jul	4	24	132
21-Jul	5	8	45
22-Jul	6	16	95
23-Jul	7	24	195
24-Jul	8	24	297
25-Jul	9	24	270
26-Jul	10	24	294
27-Jul	11	24	540
28-Jul	12	24	960
29-Jul	13	24	1,143
30-Jul	14	24	1,518
31-Jul	15	24	1,359
1-Aug	16	24	1,839
2-Aug	17	24	1,506
3-Aug	18	24	1,560
4-Aug	19	24	1,761
5-Aug	20	24	2,019
6-Aug	21	24	2,445
7-Aug	22	24	2,616
8-Aug	23	24	2,817
9-Aug	24	24	2,916
10-Aug	25	24	2,487
11-Aug	26	24	2,364
12-Aug	27	24	2,130
13-Aug	28	24	2,280
14-Aug	29	24	1,677
15-Aug	30	24	1,434
16-Aug	31	24	1,176
17-Aug	32	24	915
18-Aug	33	24	1,233
19-Aug	34	24	1,179
20-Aug	35	24	1,179
21-Aug	36	12	1,503
Total			46,251

Table A6.–Estimated proportions and mean length by age and sex of Chinook salmon sampled during the Salcha River carcass survey, 2011.

	Sample	Sample	Length (mm)			
Age[a]	Size	Proportion	Mean	SE	Min	Max
Males						
1.1	1	<0.01	360	-	-	-
1.2	77	0.25	548	5	450	680
1.3	175	0.57	687	4	515	795
1.4	48	0.16	831	9	715	1,015
2.3	3	0.01	662	32	610	720
1.5	1	<0.01	940	-	-	-
Total Aged	305	0.58	674	6	360	1,015
Total Males[b]	349	0.58	676	6	360	1,015
Adjusted Total[c]	-	0.64	-	-	-	-
Female						
1.3	12	0.05	775	19	680	935
1.4	203	0.91	848	3	740	945
1.5	7	0.03	871	8	845	910
Total Aged	222	0.42	846	3	680	945
Total Females[b]	251	0.42	844	5	670	945
Adjusted Total[c]		0.36	-	-	-	-

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents 1 annulus formed during river residence and 4 annuli formed during ocean residence plus 1 year for year of spawning for a total age of 6 years).

[b] Estimated proportion of females was corrected by a factor of 0.867.

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Table A7.– Estimated proportions and mean length by age and sex of Chinook salmon sampled during the Salcha River carcass survey, 2012.

	Sample	Sample	Length (mm)			
Age[a]	Size	Proportion	Mean	SE	Min	Max
Males						
1.1	1	0.01	366	-	-	-
1.2	25	0.15	569	7	500	628
1.3	86	0.51	711	6	597	849
1.4	57	0.34	822	8	703	990
Total Aged	169	0.40	720	9	366	990
Total Males[b]	208	0.41	729	8	366	990
Adjusted Total[c]	-	0.49	-	-	-	-
Female						
1.3	52	0.58	766	5	650	841
1.4	192	0.34	832	3	724	940
1.5	7	0.02	890	13	833	930
Total Aged	251	0.60	816	5	650	940
Total Females[b]	296	0.59	819	4	650	955
Adjusted Total[c]		0.51	-	-	-	-

[a] Age is represented by the number of annuli formed during river residence and ocean residence (i.e., an age of 1.4 represents 1 annulus formed during river residence and 4 annuli formed during ocean residence plus 1 year for year of spawning for a total age of 6 years).

[b] Estimated proportion of females was corrected by a factor of 0.867.

Table A8.–Age composition and escapement estimates by gender and by all fish combined (unadjusted and adjusted) of Salcha River Chinook salmon, 1987–2012.

	Total Age (years)/European Age (freshwater years/ocean years)										Male	Male
Males	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1987	0.005	0.152	0.275	0.000	0.544	0.000	0.025	0.000	0.000	0.000	1,766	2,290
1988	0.007	0.333	0.330	0.000	0.243	0.000	0.083	0.003	0.000	0.000	2,223	2,363
1989	0.012	0.107	0.548	0.000	0.333	0.000	0.000	0.000	0.000	0.000	1,477	1,853
1990	0.004	0.333	0.352	0.000	0.268	0.000	0.042	0.000	0.000	0.000	5,832	6,845
1991	0.004	0.143	0.489	0.000	0.309	0.000	0.051	0.000	0.004	0.000	3,082	3,325
1992	0.019	0.543	0.338	0.007	0.084	0.005	0.005	0.000	0.000	0.000	5,020	5,031
1993	0.012	0.384	0.454	0.000	0.146	0.003	0.000	0.000	0.000	0.000	7,364	7,613
1994	0.010	0.035	0.561	0.000	0.366	0.000	0.028	0.000	0.000	0.000	9,825	11,251
1995	0.000	0.296	0.292	0.000	0.388	0.000	0.021	0.004	0.000	0.000	6,013	7,023
1996	0.054	0.118	0.567	0.000	0.177	0.000	0.084	0.000	0.000	0.000	3,777	5,588
1997	0.000	0.256	0.244	0.000	0.489	0.000	0.011	0.000	0.000	0.000	9,597	10,488
1998	0.035	0.070	0.756	0.000	0.128	0.000	0.012	0.000	0.000	0.000	3,532	3,716
1999	0.000	0.201	0.374	0.000	0.424	0.000	0.000	0.000	0.000	0.000	4,471	4,834
2000	0.000	0.304	0.565	0.000	0.130	0.000	0.000	0.000	0.000	0.000	2,776	2,846
2001	0.008	0.167	0.425	0.000	0.400	0.000	0.000	0.000	0.000	0.000	8,395	8,995
2002	0.000	0.554	0.190	0.000	0.179	0.000	0.076	0.000	0.000	0.000	5,907	6,288
2003	0.011	0.126	0.598	0.000	0.241	0.000	0.023	0.000	0.000	0.000	8,964	10,181
2004	0.000	0.247	0.176	0.000	0.576	0.000	0.000	0.000	0.000	0.000	5,910	7,168
2005	0.000	0.204	0.516	0.000	0.265	0.000	0.011	0.004	0.000	0.000	2,709	3,168
2006	0.000	0.101	0.715	0.000	0.174	0.000	0.010	0.000	0.000	0.000	5,989	6,659
2007	0.000	0.343	0.364	0.000	0.293	0.000	0.000	0.000	0.000	0.000	4,130	4,436
2008	0.011	0.163	0.658	0.000	0.168	0.000	0.000	0.000	0.000	0.000	3,307	3,571
2009	0.000	0.520	0.315	0.000	0.165	0.000	0.000	0.000	0.000	0.000	7,774	8,446
2010	0.007	0.352	0.571	0.007	0.052	0.010	0.000	0.000	0.000	0.000	4,250	4,501
2011	0.003	0.252	0.574	0.000	0.157	0.010	0.003	0.000	0.000	0.000	4,188	4,589
2012	0.006	0.148	0.509	0.000	0.337	0.000	0.000	0.000	0.000	0.000	2,957	3,517
Average	0.008	0.248	0.452	0.001	0.271	0.001	0.019	0.000	0.000	0.000	5,054	5,645

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Females	Total Age (years)/European Age (freshwater years/ocean years)										Female	Female
	3	4	5		6		7		8		Unadjusted[a]	Adjusted[b]
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Escapement
1987	0.000	0.003	0.038	0.000	0.849	0.000	0.110	0.000	0.000	0.000	3,005	2,481
1988	0.000	0.005	0.066	0.000	0.690	0.000	0.239	0.000	0.000	0.000	2,099	1,959
1989	0.000	0.000	0.131	0.000	0.730	0.000	0.139	0.000	0.000	0.000	1,817	1,441
1990	0.000	0.008	0.147	0.000	0.713	0.000	0.132	0.000	0.000	0.000	4,896	3,883
1991	0.000	0.000	0.133	0.000	0.680	0.000	0.183	0.000	0.004	0.000	2,526	2,283
1992	0.000	0.005	0.327	0.000	0.650	0.000	0.014	0.005	0.000	0.000	2,842	2,831
1993	0.000	0.008	0.224	0.000	0.736	0.000	0.032	0.000	0.000	0.000	2,643	2,394
1994	0.000	0.017	0.185	0.000	0.721	0.004	0.073	0.000	0.000	0.000	8,574	7,148
1995	0.000	0.010	0.138	0.000	0.816	0.000	0.030	0.007	0.000	0.000	7,630	6,620
1996	0.000	0.005	0.205	0.000	0.390	0.000	0.400	0.000	0.000	0.000	3,793	1,982
1997	0.000	0.033	0.044	0.000	0.900	0.000	0.022	0.000	0.000	0.000	8,917	8,026
1998	0.000	0.000	0.649	0.000	0.297	0.000	0.054	0.000	0.000	0.000	1,495	1,311
1999	0.000	0.000	0.131	0.000	0.863	0.000	0.006	0.000	0.000	0.000	4,727	4,364
2000	0.000	0.111	0.389	0.000	0.389	0.000	0.111	0.000	0.000	0.000	1,819	1,749
2001	0.000	0.000	0.194	0.000	0.722	0.000	0.083	0.000	0.000	0.000	4,933	4,333
2002	0.000	0.000	0.041	0.000	0.776	0.000	0.184	0.000	0.000	0.000	3,093	2,712
2003	0.000	0.000	0.211	0.000	0.754	0.000	0.035	0.000	0.000	0.000	6,536	5,319
2004	0.000	0.000	0.028	0.000	0.958	0.000	0.014	0.000	0.000	0.000	9,851	8,593
2005	0.000	0.000	0.330	0.000	0.627	0.000	0.043	0.000	0.000	0.000	3,279	2,820
2006	0.000	0.000	0.204	0.000	0.760	0.005	0.032	0.000	0.000	0.000	4,690	4,020
2007	0.000	0.009	0.100	0.000	0.882	0.000	0.009	0.000	0.000	0.000	2,295	1,989
2008	0.000	0.000	0.303	0.000	0.655	0.000	0.042	0.000	0.000	0.000	2,108	1,844
2009	0.000	0.000	0.056	0.000	0.939	0.000	0.006	0.000	0.000	0.000	5,000	4,328
2010	0.000	0.032	0.584	0.000	0.344	0.000	0.016	0.024	0.000	0.000	1,885	1,634
2011	0.000	0.000	0.054	0.000	0.914	0.000	0.032	0.000	0.000	0.000	3,012	2,611
2012	0.000	0.000	0.207	0.000	0.765	0.000	0.028	0.000	0.000	0.000	4,208	3,648
Average	0.000	0.009	0.197	0.000	0.712	0.000	0.079	0.001	0.000	0.000	4,146	3,555

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Unadjusted[b]	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1987	0.002	0.058	0.126	0.000	0.736	0.000	0.078	0.000	0.000	0.000	4,771	MR
1988	0.004	0.203	0.225	0.000	0.421	0.000	0.145	0.002	0.000	0.000	4,322	MR
1989	0.005	0.041	0.290	0.000	0.579	0.000	0.086	0.000	0.000	0.000	3,294	MR
1990	0.002	0.169	0.249	0.000	0.492	0.000	0.087	0.000	0.000	0.000	10,728	MR
1991	0.002	0.076	0.322	0.000	0.483	0.000	0.113	0.000	0.004	0.000	5,608	MR
1992	0.012	0.361	0.334	0.005	0.276	0.003	0.008	0.002	0.000	0.000	7,862	MR
1993	0.009	0.280	0.391	0.000	0.309	0.002	0.009	0.000	0.000	0.000	10,007	CT
1994	0.006	0.027	0.392	0.000	0.525	0.002	0.048	0.000	0.000	0.000	18,399	CT
1995	0.000	0.136	0.206	0.000	0.628	0.000	0.026	0.006	0.000	0.000	13,643	CT
1996	0.027	0.061	0.383	0.000	0.286	0.000	0.245	0.000	0.000	0.000	7,570	MR
1997	0.000	0.144	0.144	0.000	0.694	0.000	0.017	0.000	0.000	0.000	18,514	CT
1998	0.024	0.049	0.724	0.000	0.179	0.000	0.024	0.000	0.000	0.000	5,027	CT
1999	0.000	0.091	0.241	0.000	0.664	0.000	0.003	0.000	0.000	0.000	9,198	CT
2000	0.000	0.220	0.488	0.000	0.244	0.000	0.049	0.000	0.000	0.000	4,595	CT
2001	0.005	0.104	0.339	0.000	0.521	0.000	0.031	0.000	0.000	0.000	13,328	CT
2002	0.000	0.362	0.138	0.000	0.387	0.000	0.113	0.000	0.000	0.000	9,000	CT
2003	0.007	0.076	0.444	0.000	0.444	0.000	0.028	0.000	0.000	0.000	15,500	CT
2004	0.000	0.092	0.083	0.000	0.817	0.000	0.009	0.000	0.000	0.000	15,761	CT
2005	0.000	0.093	0.415	0.000	0.462	0.000	0.028	0.002	0.000	0.000	5,988	CT
2006	0.000	0.057	0.493	0.000	0.428	0.002	0.020	0.000	0.000	0.000	10,679	CT
2007	0.000	0.224	0.269	0.000	0.503	0.000	0.003	0.000	0.000	0.000	6,425	CT
2008	0.007	0.099	0.518	0.000	0.360	0.000	0.017	0.000	0.000	0.000	5,415	CT
2009	0.000	0.317	0.214	0.000	0.467	0.000	0.002	0.000	0.000	0.000	12,774	CT
2010	0.005	0.255	0.575	0.005	0.141	0.007	0.005	0.007	0.000	0.000	6,135	CT
2011	0.002	0.146	0.355	0.000	0.476	0.006	0.015	0.000	0.000	0.000	7,200	CT
2012	0.002	0.060	0.329	0.000	0.593	0.000	0.017	0.000	0.000	0.000	7,165	CT
Average	0.005	0.146	0.334	0.000	0.466	0.001	0.047	0.001	0.000	0.000	9,189	

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Adjusted	Total Age (years)/European Age (freshwater years/ocean years)											
All Fish	3	4	5		6		7		8		Total	
Year	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Escapement	Method[c]
1987	0.002	0.074	0.151	0.000	0.703	0.000	0.069	0.000	0.000	0.000	4,771	MR
1988	0.004	0.185	0.210	0.000	0.446	0.000	0.154	0.002	0.000	0.000	4,322	MR
1989	0.007	0.060	0.366	0.000	0.507	0.000	0.061	0.000	0.000	0.000	3,294	MR
1990	0.002	0.215	0.278	0.000	0.429	0.000	0.075	0.000	0.000	0.000	10,728	MR
1991	0.002	0.085	0.344	0.000	0.460	0.000	0.105	0.000	0.004	0.000	5,608	MR
1992	0.012	0.349	0.334	0.004	0.288	0.003	0.008	0.002	0.000	0.000	7,862	MR
1993	0.009	0.298	0.402	0.000	0.281	0.002	0.007	0.000	0.000	0.000	10,007	CT
1994	0.006	0.028	0.409	0.000	0.509	0.002	0.046	0.000	0.000	0.000	18,399	CT
1995	0.000	0.158	0.217	0.000	0.595	0.000	0.025	0.005	0.000	0.000	13,643	CT
1996	0.040	0.089	0.472	0.000	0.233	0.000	0.167	0.000	0.000	0.000	7,570	MR
1997	0.000	0.163	0.161	0.000	0.661	0.000	0.016	0.000	0.000	0.000	18,514	CT
1998	0.026	0.052	0.728	0.000	0.172	0.000	0.023	0.000	0.000	0.000	5,027	CT
1999	0.000	0.112	0.266	0.000	0.620	0.000	0.003	0.000	0.000	0.000	9,198	CT
2000	0.000	0.238	0.505	0.000	0.219	0.000	0.038	0.000	0.000	0.000	4,595	CT
2001	0.006	0.113	0.351	0.000	0.503	0.000	0.027	0.000	0.000	0.000	13,328	CT
2002	0.000	0.389	0.146	0.000	0.357	0.000	0.108	0.000	0.000	0.000	9,000[d]	CT
2003	0.007	0.080	0.456	0.000	0.429	0.000	0.027	0.000	0.000	0.000	15,500[d]	CT
2004	0.000	0.113	0.096	0.000	0.783	0.000	0.008	0.000	0.000	0.000	15,761	CT
2005	0.000	0.107	0.428	0.000	0.437	0.000	0.026	0.002	0.000	0.000	5,988	CT
2006	0.000	0.062	0.520	0.000	0.397	0.002	0.019	0.000	0.000	0.000	10,679	CT
2007	0.000	0.240	0.282	0.000	0.475	0.000	0.003	0.000	0.000	0.000	6,425	CT
2008	0.007	0.108	0.538	0.000	0.333	0.000	0.014	0.000	0.000	0.000	5,415[d]	CT
2009	0.000	0.343	0.227	0.000	0.427	0.000	0.002	0.000	0.000	0.000	12,774	CT
2010	0.005	0.267	0.575	0.005	0.130	0.008	0.004	0.006	0.000	0.000	6,135	CT
2011	0.002	0.161	0.385	0.000	0.432	0.006	0.014	0.000	0.000	0.000	7,200	CT
2012	0.003	0.073	0.355	0.000	0.555	0.000	0.014	0.000	0.000	0.000	7,165	CT
Average	0.006	0.164	0.353	0.000	0.433	0.001	0.043	0.001	0.000	0.000	9,189	

[a] Unadjusted escapement and composition estimates were derived from the observed sample proportions of males and females from carcass surveys.

[b] Adjusted escapement and composition estimates were derived either from mark-recapture estimates (MR) or in years when counting tower (CT) assessments were conducted, from carcass surveys that were adjusted using equations 16-18 and do not necessarily reflect actual sample proportions.

[c] Escapement estimates were obtained from either a counting tower (CT) assessment or mark-recapture (MR) project.

[d] Estimate includes an expansion for missed counting days. SE is a minimum estimate and does not include uncertainty associated with expansion for missed days.

APPENDIX B: GOODPASTER RIVER CHINOOK SALMON COUNTING TOWER DATA

Appendix B1.–Data summaries and estimates of escapement of Chinook salmon from counting tower projects by Tanana Chiefs Conference on the Goodpaster River, 2011–2012.

Appendix B: List of Figures

Appendix B: List of Tables

INTRODUCTION

The Chinook salmon counting tower on the Goodpaster River began operations in 2004. It is operated by staff from Tanana Chiefs Conference (TCC) and the Bering Sea Fisherman's Association. Further details regarding this project can be obtained by contacting the TCC.

Unlike the Chena and Salcha rivers, the Goodpaster River does not have an escapement goal and counts are not provided to the fisheries managers on a daily basis. In the future, as a longer time series is developed, an escapement goal may be developed and managed for.

METHODS

Project mobilization, escapement enumeration, and data analysis procedures for the Goodpaster River counting tower were similar to those used for the Chena River.

The Goodpaster River has not been sampled for Chinook salmon ASL composition, although samples have been taken for genetic identification.

RESULTS

In 2011, the Goodpaster River counting tower (Figure B1) was in operation from 12 July through 4 August; the estimated Chinook salmon escapement during that time was 1,325 (SE=not reported) (Tables B1 and B2).

In 2012, the Goodpaster River counting tower (Figure B1) was in operation from 16 July through 4 August; the estimated Chinook salmon escapement during that time was 778 (SE=not reported) (Tables B1 and B3).

It is unknown what proportion of the Goodpaster River Chinook salmon stock may spawn up the South Fork of the river, but various surveys have shown little if any spawning occurring on the South Fork as habitat is unsuitable for at least the vast majority of the drainage, therefore the estimates of escapements produced by this project should not be considered totally inclusive, but rather representative of the Goodpaster River, until such time as the significance of the South Fork can be ascertained.

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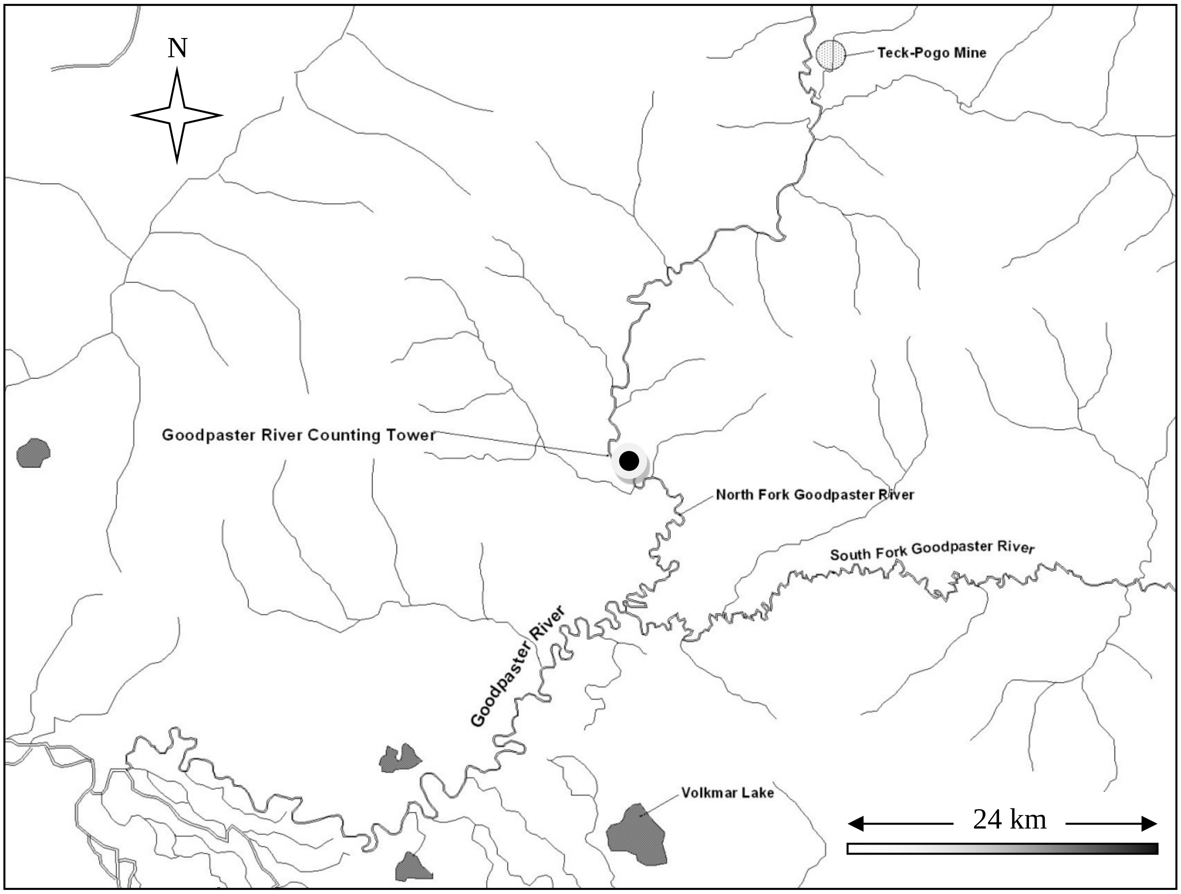

Figure B1.–Map of the Goodpaster River showing the location of the counting tower.

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Table B1.–Estimates of the Goodpaster River Chinook salmon escapement, 2004–2012.

	Escapement	
Year	Estimate	SE
2004	3,673	106
2005	1,184	70
2006	2,479	100
2007	1,581	82
2008	1,880	85
2009	4,280	167
2010	1,125	66
2011	1,325	Not Reported
2012	778	Not Reported

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Table B2.–Daily estimates of Goodpaster River Chinook salmon escapement, 2011. Bold numbers are interpolated using historic daily passage percentages.

Date	Number 20 Min Counts	Daily Escapement
12-Jul	9	6
13-Jul	24	6
14-Jul	24	42
15-Jul	24	51
16-Jul	24	27
17-Jul	22	111
18-Jul	20	66
19-Jul	20	150
20-Jul	0	**150**
21-Jul	0	**150**
22-Jul	8	**100**
23-Jul	16	**100**
24-Jul	21	72
25-Jul	24	54
26-Jul	22	57
27-Jul	0	**50**
28-Jul	0	**40**
29-Jul	0	**30**
30-Jul	0	**20**
31-Jul	0	**10**
1-Aug	8	6
2-Aug	24	0
3-Aug	24	12
4-Aug	24	15
Total		1,325

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Table B3.–Daily estimates of Goodpaster River Chinook salmon escapement, 2012. Bold numbers are interpolated using historic daily passage percentages.

Date	Number 20 Min Counts	Daily Escapement
16-Jul	5	12
17-Jul	24	9
18-Jul	24	18
19-Jul	24	24
20-Jul	24	72
21-Jul	24	**48**
22-Jul	24	**73**
23-Jul	24	**60**
24-Jul	24	72
25-Jul	24	30
26-Jul	24	57
27-Jul	24	45
28-Jul	24	54
29-Jul	24	33
30-Jul	24	39
31-Jul	24	30
1-Aug	24	30
2-Aug	24	42
3-Aug	24	24
4-Aug	13	6
Total		778